REPORT

OF THE

Agricultural Research Institute and College, Pusa.

(Including Report of the Imperial Cotton Specialist)

1909-10

CALCUTTA
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Report of the Agricultural Research Institute and College, Pusa.

(Including Report of the Imperial Cotton Specialist.)

1909-10.

INTRODUCTORY.

IN presenting the report of the past year of the Agricultural Research Institute and College at Pusa, and that of the Imperial Cotton Specialist, I shall confine myself to a brief mention of the more important work undertaken in each section.

Agriculture.—The *Permanent Manurial and Rotation* experiments and the *Permanent Pasture* experiments have been continued according to the scheme described in the Proceedings of the Board of Agriculture, 1908. Sufficient time has not elapsed for making deductions from their results. Perhaps amongst the most useful work carried out is that of the preservation of fodder. In a country like India where cattle-food supplies are subject to the vicissitudes of an uncertain climate, this subject is of the highest interest. The production of ensilage on the American principle has been found the most satisfactory method of preservation. Maize was found to give the most nutritious food when thus prepared, but in point of yield per acre sorghum has given more weight and is therefore more economical. An objection to the American system of making ensilage in this country is the expense of constructing the silo. Experiments, however, are in progress

with a view of devising a cheap indigenous pattern which, if successful, will not only enable the better class of cultivator to adopt siloing, but will be of use perhaps to Government Departments in the preservation of fodder against famine years. As regards future work, that coming under the head of " Extension of Botanical Work " will doubtless prove the most important. The growth of selected varieties of wheats in extension of the work now being done by the Imperial Economic Botanist will be carried out on a practical scale with a view to still further extension in the future.

Botany.—No part of a scheme for the improvement of agriculture gives greater promise of success than that which deals with improvements emanating from the treatment of the plant. This is especially the case in India where not only are the plants of most crops degenerated specimens, but where the poverty of the cultivator makes improvement entailing the use of capital well-nigh impossible. By the introduction of a better plant, it is easily possible to increase yield and improve quality without adding to the cost of cultivation. The work which Mr. A. Howard, the Imperial Economic Botanist, is carrying out on *wheat* requires special recognition. The wheats which were sent home last year for testing have been found to rank in the same class as American and Canadian Spring wheats which command the highest price in the English market. It is almost needless to point out that these facts should have a most profound effect upon the export wheat trade of India. I desire here to record the appreciation felt for the invaluable assistance given by Mrs. Howard, who equally with her husband has accounted for the work of this Section.

Chemistry.—The principal work undertaken by this department during the past year has been the study of *Soil Gases* in relation to other constituents in the soil, the examination into the nature of *Usar* land and the investigations into the *Water Requirements of Crops.* The work of the first two is not in a sufficiently advanced stage to

need reference at this moment, but attention may be invited to Dr. Leather's work on the *Water Requirements of Crops.* In India where water is the prime factor underlying the successful growth of crops, its conservation and its economic use are of first rate importance. These remarks apply equally whether the water is derived from the monsoon rainfall or the irrigation canal. How much water is transpired by various crops, and during what period of growth does the crop require the principal portion of this water, are questions of as great importance to the agriculturist as to the irrigation engineer. In Chapter XI of the Report of the Indian Irrigation Commission, 1901-1903, the Commissioners remarked, "In the course of our investigations, we have been struck with the small amount of attention which appears to have been given by the Departments of Agriculture and Public Works to matters connected with the application of water to cultivated crops. At present, most of the information which can be had on these points has to be taken from papers published by the Agricultural Bureau in America. . . . . We consider it extremely desirable that expert enquiry should be directed to these important matters, which are so intimately connected with the development of irrigation."

This enquiry Dr. Leather has undertaken and in Memoir No. 8, Chemical Series, he has published the results of his work on the first section of the investigation, namely, that which deals with the total amount of water transpired by the crop and the period of growth during which the greater part is assimilated. The ratio between the amount of water transpired and the ultimate weight of dry crop is worked out for most of the principal Indian crops.

Entomology.—One of the principal features of the work of this section is the attention which is being paid to industries that depend upon the products of insects. Thus Eri, Mulberry and Tussar silk and the cultivation of Lac are taking up much of the time of Mr. Maxwell-Lefroy, the Imperial Entomologist, and his staff. The Eri silk industry

has spread considerably in Tirhoot, Bhagalpur and Patna, where owing to their proximity, these places are under the direct influence of this Institute. It is also to be found in Malabar, Dharwar, the West Coast, Gujarat, Kathiawar, Sind, Patiala, Rohilkhund, Betul, Chanda and Murshidabad. Progress is at present somewhat retarded by the want of middlemen for collecting the cocoons from the rearers and conveying them to the mills, but it is expected that enterprise will eventually overcome this difficulty.

Mycology.—The investigation into the *Blister Blight of Tea* carried out by Mr. W. McRae while he officiated as Imperial Mycologist, has been the most important new work undertaken during the year. The disease which has been known for years in North-East Assam appeared for the first time in Darjeeling in 1908. In 1909, it extended, and this led to the Darjeeling Planters' Association asking the assistance of this Institute. It has spread still further this year into the Dooars and the Terai and its progress will be watched with anxiety by all interested in tea.

The *Palm Disease* in the Godavery Delta has not ceased to engage the attention of this Department, and recommendations have been made for continuing the work of repression, especially in the Kistna District where, in spite of the repeated warnings of the Imperial Mycologist, it was being neglected. A full account of the disease and measures taken to check it is in the press and will appear shortly.

Bacteriology.—It is only necessary to mention that with the appointment of Mr. C. M. Hutchinson as Imperial Agricultural Bacteriologist, this section has been opened during the year. The importance of the study of the biological aspect of soils in this country cannot be overestimated, and much useful information is anticipated from investigations in this quarter.

Cotton.—The importance of the cotton plant not only to India but to the British Empire has led the Government

to appoint a whole-time officer for this particular crop. Mention may here be made of the more important recommendations of the Imperial Cotton Specialist which will be found embodied in his report in greater detail. In *Eastern Bengal and Assam*, the prevalent type is that known as *Gossypium neglectum* var. *Assamica* of Watt and is commonly called the Garo Hill Cotton. It is not used in commerce as cotton but as a substitute or adulterant in wool manufacture and any attempt to improve it from the point of view of the cotton merchant would result in a serious diminution of price. The Imperial Cotton Specialist recommends that in any experiments carried out by the Department, this type of cotton should be adhered to, lest the experience of generations which has taught the use of a kind of cotton capable of growing under excessive rainfall and the primitive agriculture of the Hill tracts, be lost and the present variety substituted by an unsuitable one. He, therefore, advises that trials should be confined to improving in this one type, the length of staple and the percentage of cotton to seed but that no attempt should be made to alter the special characteristics of the product.

In *Bengal* the cottons appear altogether to be of an inferior type. Trials should be confined in this Province to the possibilities of *G. intermedium* and *G. hirsutum*, the latter preferably in its two forms of *Buri* and Cambodia.

In the *Central Provinces*, it is pleasant to find that Mr. Clouston, Deputy Director of Agriculture, has selected a plant of the *Buri* variety which is promising well and that most valuable work is being done in these provinces by the introduction of *Buri*. The recommendations of the Imperial Cotton Specialist in regard to these provinces may be summarised as under :—

(1) The introduction of *Buri* to accompany *Bani* but not to oust *Jari*.

(2) The improvement of *Bani* in its percentage of cotton.

(3) The isolation of the different types of *Jari*.

The report of the Imperial Cotton Specialist so far as other Provinces are concerned does not call for any comment.

Publications.—In addition to the Agricultural Journal of India, the Memoirs of the Department of Agriculture in India, Bulletins and Leaflets, two publications of importance have issued from the Institute during the past year, namely, *Indian Insect Life* by Mr. Maxwell-Lefroy assisted by Mr. F. M. Howlett and *Wheat in India* by Mr. and Mrs. Howard. *Indian Insect Life* containing 786 pages of printed matter and 619 illustrations has been well received both in India and abroad and is without doubt the most advanced and comprehensive manual of Indian insects yet published. *Wheat in India* containing 288 pages and 18 illustrations, deals in a complete manner with the production, varieties and improvement of Indian wheat. In order to be useful to all interested in the various aspects of wheat production, the scope of the book has been made as wide as possible.

Students.—Out of the students admitted in the previous year, nine continued their course and of these seven left during the year after the completion of their training and one was recalled to his province before the expiry of his term. Four new students were admitted during the year, *viz.*, one each in Chemistry, Mycology, Entomology and Agriculture. In the short practical courses in Agriculture, Fruit-growing, Silk-culture, Lac cultivation, Cattle Breeding and Management and the like, 39 students were admitted, some of whom took up more than one subject.

BERNARD COVENTRY,
Offg. Inspector General
of Agriculture in India.

SIMLA;
The 1st October 1910.

REPORT OF THE DIRECTOR, AGRICULTURAL RESEARCH INSTITUTE AND COLLEGE, PUSA, FOR THE YEAR 1909-1910.

(E. J. BUTLER, M.B., F.L.S.)

1. *Charge of Office.*—Mr. B. Coventry held charge of the office of Director up to the 9th May 1910, with the exception of one month in September-October 1909, when he was on privilege leave and Mr. H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, acted for him during his absence in addition to his own duties. In consequence of his appointment as Officiating Inspector General of Agriculture in India, Mr. Coventry relinquished charge of the office of Director on the 9th May 1910, and I was appointed to officiate for him in addition to my own duties.

2. *Staff.*—Dr. J. Walter Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, returned from leave on the 27th October 1909 and took over charge of the chemical section from Mr. H. E. Annett. The latter has been deputed to act as Agricultural Chemist, United Provinces, from the 3rd November 1909. The charge of the mycological section was taken over by me from Mr. W. McRae, M.A., B.Sc., on the 27th December 1909, when I returned from leave, and immediately after Mr. McRae proceeded to Madras to join his new appointment as Mycologist to the Government of Madras. His successor, Mr. F. J. F. Shaw, B. Sc., A.R.C.S., joined his appointment as Supernumerary Mycologist on the 28th January 1910. Mr. C. W. Mason, Supernumerary Entomologist, left the Department on the 19th December 1909, and Mr. T. Bainbrigge-Fletcher, R.N., F.E.S., joined this Institute as Supernumerary Entomologist on the 8th April 1910. The Second Imperial Entomologist, Mr. F. M. Howlett, B.A., F.E.S., has been on leave since the 9th September 1909 and

is expected to return in January next. Mr. C. M. Hutchinson, B.A., joined the Department on the 24th December 1909, as Imperial Agricultural Bacteriologist. The charge of the Farm was relinquished by Mr. E. Shearer, Imperial Agriculturist, on the 17th July 1909, in consequence of his promotion to the post of Assistant Inspector General of Agriculture in India and the Director was placed in charge of the duties of the Imperial Agriculturist in addition to his own duties. Mr. G. C. Sherrard, B.A., Supernumerary Agriculturist, was appointed to be Assistant Agriculturist with effect from 17th July 1909. He was on privilege leave from 2nd to 20th November 1909, and from 6th June 1910 to 6th July 1910. Mr. A. McKerral, M.A., B.Sc., who has been appointed Assistant Inspector General of Agriculture in India, *vice* Mr. E. Shearer, resigned, has been lent to the Pusa staff to undertake the work of Imperial Agriculturist under the Director as a provisional measure. He joined his duties at this Institute on the 19th June 1910. The botanical section was in charge of Mr. A. Howard, M.A., A.R.C.S., F.L.S., up to 30th April 1910, when he proceeded on leave to England. Mr. G. P. Hector, M.A., B.Sc., Supernumerary Botanist, was transferred to Eastern Bengal and Assam on the 14th July 1909, and the services of Mr. E. Holmes-Smith, B.Sc., Economic Botanist designate of Burma, were transferred to this Department with effect from the 15th July 1909, for appointment as Supernumerary Botanist. The latter has been on deputation in the Bombay Presidency since the 6th March 1910, to acquire experience of work in a province.

The European Scientific Staff of the Institute consisted of the following :—

(1) The Imperial Agricultural Chemist with one Supernumerary, (2) the Imperial Mycologist with one Supernumerary, (3) the Imperial Entomologist with one Supernumerary, (4) the Imperial Economic Botanist with one Supernumerary, (5) the Second Imperial Entomologist, (6)

the Imperial Agricultural Bacteriologist, (7) the Assistant Inspector General of Agriculture in India (temporarily in charge of the agricultural section) with the Assistant Agriculturist.

During the year under report, the pay and position of several of the senior Indian assistants of the institute were improved and the first assistants in each section as well as other assistants engaged in teaching and research work have been admitted to gazetted rank.

3. *Scientific Work.*—The scientific work of the Institute during the year is indicated in the reports of the various Sections.

4. *Buildings, Grounds, etc.*—In consequence of the transfer of the head-quarters of the Inspector General of Agriculture in India to Pusa, two blocks of new quarters have been departmentally constructed for the use of his staff and in addition some old buildings have been placed at his disposal. The grounds surrounding the College building have been fully laid out and arrangements made for irrigating the lawns.

5. *Students.*—Out of the students admitted in the previous year, 9 continued their course and of these 7 left during the year after the completion of their training and one was recalled to his province before the expiry of his term. Four new students were admitted during the year, *viz.*, one in Chemistry (an Assistant of the Agricultural Chemist, United Provinces) for a three months' course, one in Mycology (a private student from Bombay), one in Entomology, from the Central Provinces Department of Agriculture, and one for a general course in Agriculture from the Punjab Department of Agriculture. The private student in Mycology has, however, abandoned the course and left the Institute. There were at the end of the year four students under training, *viz.*, one in Chemistry, two in Entomology and one for a general course.

The short courses in practical agriculture and in other allied practical subjects inaugurated last year at Pusa

were continued. The number of students admitted to the various sections for these courses was as follows :—Six in fruit-growing, eighteen in silk-culture, ten in lac cultivation, nine in cattle breeding and management, three in poultry management and three in tillage implements and agricultural machinery. The students for these courses came from different parts of India and some of them took up more than one subject.

6. *Publications.*—This work has been continued. During the year under report two new books, one " Indian Insect Life " by Mr. H. Maxwell-Lefroy, Imperial Entomologist, assisted by Mr. F. M. Howlett, Second Imperial Entomologist, and the other " Wheat in India " by Mr. A. Howard, Imperial Economic Botanist, and Mrs. Howard, were published in addition to the Agricultural Journal of India, the Memoirs of the Department of Agriculture in India, Bulletins and Leaflets.

7. *Library.*—The revised catalogue of the library is still in the press. Over a thousand volumes have been added to the library during the year.

8. *General Health of the Station.*—The general health of the station during the year under report was good, excepting in the monsoon period. Relief was afforded in the hospital to 6,231 new cases, of which 6,015 were treated in the outdoor department and 216 admitted as indoor patients. These figures show an increase of 2,918 and 112 respectively over last year's totals. The increase in attendance was due to the greater prevalence of malarial and allied fevers during the months of July, August and September, 1909. 99 cases amongst European officers and their families were attended to.

The daily average number of patients treated was 6·96 indoor and 48·97 out-door as against 4·68 and 25·05 respectively during the previous 12 months.

Five deaths occurred in hospital—two cases from pneumonia in aged and debilitated subjects, one from malarial cachexia and two from *Kala-Azar.*

Eighty-eight surgical operations were performed, of which 4 were major and the remainder minor.

The prevailing diseases were malarial fevers, bowel complaints and rheumatic and skin affections. Malarial fever cases were diagnosed microscopically before treatment.

There were no cases of infectious diseases, except a case of chicken-pox (imported). Eight primary and three revaccinations were performed in the early part of the year.

9. *Accounts.*—The total expenditure incurred during the year was Rs. 3,12,427 as against Rs. 3,23,900 of the preceding year. The principal items of expenditure are pay of gazetted officers and establishment Rs. 1,78,680, travelling allowance of officers and establishment Rs. 14,699, publications Rs. 30,000 and farm expenditure, scientific apparatus, books, contingencies, etc., Rs. 89,048.

The gross receipts during the year by sale of farm produce, milk and other miscellaneous articles amounted to Rs. 5,573 as against Rs. 9,680 of the preceding year. The decrease is due to the abnormal rainfall (amounting to 72 inches) which damaged the crops.

REPORT OF THE IMPERIAL AGRICULTURIST FOR THE YEAR 1909-10.

(A. McKerral, M.A., B.Sc.)

1. *Charge and Establishment.*—Mr. Ernest Shearer, Imperial Agriculturist, relinquished charge of the farm on 16th July 1909 on his promotion to the post of Assistant Inspector General of Agriculture in India, and his duties were taken up by Mr. Bernard Coventry, the Director, Agricultural Research Institute, in addition to his own work. Mr. G. Sherrard, who had previously acted as Supernumerary Agriculturist, was appointed Assistant Agriculturist. Amongst the subordinate staff, Mr. G. N. Desai, First Farm Overseer, was transferred in March 1910, to the Agricultural Department of the Bombay Presidency, and Mr. Ikramuddin, the Second Farm Overseer, was promoted to First Farm Overseer in his place. Mr. Ziauddin Hyder, fieldman, was in charge of the Poultry until promoted in April 1910 to the post of Second Farm Overseer, Mr. Nizamuddin Hyder being appointed in his place. Mr. Judah Hyam, the Veterinary Overseer, remained in charge of the breeding herds as before. During the year, the Government of India were pleased to raise him to Gazetted rank along with certain other Indian Assistants of the Institute.

2. *Training.*—The two students Bhai Sunder Singh and Bhai Kharak Singh, sent by the Punjab Agricultural Department for a general course of agriculture, completed their training and returned to their province to take up respectively the posts of Assistant Director of Agriculture and Assistant Professor of Agriculture. A third student, Chowdhuri Fateh-ud-din, sent by the same department, was admitted to a general course in agriculture from 18th August 1909.

Short courses in cattle breeding and management, poultry management, tillage implements, and agricultural machinery were given to some 15 students.

3. *Character of the Season.*—The rainfall for the season amounted to 72 inches, which is some 30 inches above normal. It was very badly distributed and was precipitated at times in such large quantities that the crops became injured. The result of the monsoon harvest was consequently a disappointment and the yields in no way approximated to expectation. The rain, too, was unusually heavy in the month of October, which not only retarded the preparation of the land for the *rabi* season, but caused unprecedented sickness amongst the labourers.

4. *Cropping.*—The trials with many varieties of sugarcane were continued as in previous years. In spite, however, of the care and control with which the cultivation and selection of this crop was carried out, the results were disappointing. It has been realised that the locality is unsuited to the growth of thick canes such as were being cultivated and with the exception of a small area reserved for the Mycologist and Entomologist the cultivation of this crop has been abandoned. Jute and flax have been grown for experiments for the Fibre Expert to the Government of Eastern Bengal and Assam with varying degrees of success. With regard to jute, the experiments were mostly for the purpose of determining the botanical characters in a collection of specimens. While this crop grows well in these districts, it is generally recognised that it does not do so well as in Eastern Bengal and its cultivation amongst the cultivators of Behar is not extending. With regard to flax, prospects appear promising provided the crop is grown in the best possible way, that is to say in strong land with an abundance of moisture. The work in this crop is being extended, and the experiments now in progress should solve most of the doubts and difficulties which prevent its being more generally adopted. In addition to the usual cultivation of rice carried out on the farm, the use of bone meal and saltpetre was tried in a series of $\frac{1}{4}$ acre plots. Two alternate plots were unmanured and the other two manured with 30 seers

of saltpetre and 3 maunds of bone meal per acre. The results were as under :—

	Mds	Seers.	
(1) Manured	30	17	per acre.
(2) Not manured	26	22	,,
(3) Manured	29	5	,,
(4) Not manured	26	4	,,

The result is slightly in favour of the manured plots, but the difference is not sufficient to warrant the expenditure. The remainder of the crops on the farm were grown mainly for the purpose of fodder for the increasing numbers of cattle. These crops consist chiefly of maize, sorgum, *arhar* (*Cajanus indicus*), and oats. A large number of varieties of crops in small plots were grown for the use of the Entomologist and Mycologist. The brick-field area, brought under cultivation for the first time, was sown with a mixed crop of rice, sorghum, and *moong* (*Phaseolus mungo*), and gave quite satisfactory results.

5. *Permanent Manurial and Rotation Experiments.*—These have been continued according to the scheme described in the Proceedings of the Board of Agriculture, 1908. Sufficient time has not elapsed for making deductions from these experiments.

6. *Permanent Pasture Experiments.*—The series of permanent pasture experiments laid down in the monsoon of 1907, according to the scheme described in the Proceedings of the Board of Agriculture held at Pusa in February 1908, has been maintained. The experiments aim at determining the effect of different manurial dressings (1) on the total yield of the herbage and (2) on its quality and botanical composition. So far as yield is concerned, it is much too early as yet to make any deductions, especially as the first two seasons during which the experiments took place were not normal with respect to rainfall. With regard to the quality of the herbage also, sufficient time has not elapsed for radical changes to have taken place. In fact, as the total number of species of grasses and legumes which were originally present was small, it is

scarcely to be expected that such complete alteration of the flora as has characterised similar experiments in Europe may be looked for in the case of Pusa. The condition of the plots at present may be summarised as follows :—

In the cold weather, they consist mostly of *Apang* (*Andropogon annulatus*) with a certain amount of *dubh* (*Cynodon dactylon*) and in the rains, of Digitaria and Rottboelia. At the end of the rains, the whole area is overgrown by *rari* (*Saccharum spontaneum*) and *dabhi* (*Imperata arundinacea*) which disappear entirely during the cold weather. The only legumes worthy of notice are *Medicago lupilina*, Linn., and *Indigofera linifolia*, Retz., both of which are " bottom " plants, useless for hay purposes. Weeds are practically a negligible quantity. On the whole, the composition of all the plots is as yet practically the same.

7. *Fodder.*—The supply of fodder for the cattle is one of the chief objects of the farm, and consequently by far the larger portion of the arable area is devoted to this purpose. Maize, sorghum, *arhar* (*Cajanus indicus*), and oats are the crops found most suitable. Ensilage is much resorted to, and if the process is properly carried out in silos of the American type, it is invariably a success. Maize probably gives the most nutritious food when thus prepared, but in point of yield per acre sorghum is more satisfactory and therefore more economical. The amount of silage made last year on the farm was 13,329 maunds.

8. *Breeding.* (*a*) *Cattle and Sheep.*—The Montgomery herd of cows continues to do well and its numbers have been increased. There are 62 cows, 3 bulls, and 108 young stock. The local herd of cattle which was maintained for the Bengal Government have been removed to Bettiah where they are being looked after by the Bengal Agricultural Department. This has given us more room for the extension of the Montgomery herd. The flock of 80 Bikanir sheep which were purchased two years ago have not done well. The change from an excessively arid to a humid tract caused a breakdown in their constitution and the

majority have died. The remainder will be got rid of, and in their place is being substituted a flock of Gorakhpur ewes which are good specimens of the local breed. These are at present doing well. It is intended to cross them with Dumbha rams with a view to improvement for mutton purposes.

(*b*) *Poultry Breeding.*—This work is now being conducted on a fairly large scale. The stock consists of 18 pens of fowls nearly all of pure breeds, one pen of Mammoth Bronze Turkeys, and one flock each of Embden Geese and Aylesbury ducks. The object is to supply at reasonable prices fresh blood of imported strains to Provincial Agricultural Farms and private individuals who are unable to afford the expense and risk of direct importation. This is effected either by egg distribution or by sale of birds. The price of eggs is Rs. 6 a dozen and birds are Rs. 30 for an adult trio and Rs. 16 for half grown birds. The eggs are sent by post or by rail in boxes specially made for the purpose, but it has to be acknowledged that this mode of distribution has not, by any means, been successful. The percentage of successful incubation from eggs transmitted by post or rail was extremely low, indeed so low that this method had to be discontinued. The failure is due doubtless to the fact that distances are so great in India, and the Postal and Railway authorities so unaccustomed to handling delicate articles like eggs, that the jolting and rough treatment in transit must have destroyed their fertility. The distribution of birds may be taken to have been altogether a success even in the case of long distances. The varieties of fowls which at present have done best are the Partridge Wyandotte, White Wyandotte, White Orpington, and Barred Plymouth Rocks. The Mammoth Bronze Turkeys have also done very well.

9. *Programme of work for 1910-11:*—1. *Permanent Experiments.*—The permanent manurial and rotation experiments and the pasture experiments will be continued.

2. *Extension of Botanical work.*—The growth of selected varieties of wheat will be taken up in extension of the

work now being done by the Imperial Economic Botanist. This work will be carried on in consultation with, and under the botanical surveillance of, the Imperial Economic Botanist.

3. *Cattle Breeding.*—The local herd has been transferred to the Bengal Agricultural Department and the Montgomery herd will now be considerably increased. Improvement of this breed by selection based principally on milk tests will be the chief object in view.

4. *Sheep.*—The crossing of Gorakhpur ewes with Dumbha rams will be undertaken.

5. *Poultry.*—Poultry breeding and distribution will be continued.

6. *Training.*—Courses in cattle breeding and the management of poultry will be given as heretofore.

REPORT OF THE IMPERIAL ECONOMIC BOTANIST, FOR THE YEAR 1909-10.

(A. Howard, M.A.; A.R.C.S.; F.C.S.; F.L.S.)

Part I.

Teaching, Training and Staff.—Two Supernumerary Botanists were in training during the year under review. Mr. G. P. Hector, M.A., B.Sc., the Economic Botanist-designate of Eastern Bengal and Assam, proceeded to that province on July 14th, 1909. Mr. E. Holmes-Smith, B.Sc., Supernumerary Botanist, worked at Pusa till February last when he proceeded to Bombay.

Five students attended the course on fruit growing and in addition, there were four students who attended special courses. One further short-course student was sent for a few weeks by the Economic Botanist to the Government of Bengal.

Mr. Ijaz Husain, Manager of the Lyallpur Farm, gave up his post in the Punjab Agricultural Department so as to become trained in this section as third assistant. My second assistant, Mr. Abdur Rahman Khan, has continued his training in Economic Botany in the section. I have pleasure in reporting the continued progress made by this assistant who, I believe, possesses real aptitude for and a thorough interest in Economic Botany. He is the joint author of an important memoir on some aspects of plant breeding in India recently submitted for publication.

While all other members of the staff have improved in their work, the services of my clerk, Ram Nechhawar Lal and of my second fieldman, Sarup Singh, deserve mention.

Part II.

Investigations.

Wheat.—I am able to report very considerable progress in the wheat investigations of this section along several lines.

The expectations foreshadowed in Pusa Bulletin No. 14 on the possibility of growing stronger wheats with better milling qualities than those now exported from India have been abundantly realised during the past year. A further set of Pusa selected wheats was sent to Mr. Humphries for milling tests. Several of these wheats were found to possess great strength and high milling qualities and to be of the same class as American and Canadian Spring wheats which command the highest prices on the English market. The results of this work are published in Pusa Bulletin No. 17.

The results obtained during the year on the influence of the environment on the quality of wheat have been submitted for publication as a memoir. This work, which is being conducted in collaboration with Mr. H. M. Leake, Economic Botanist to the Government of the United Provinces, has been greatly extended during the past year. While it has been proved that environment influences quality, the most practical outcome of this work is the discovery of the fact that the quality of any wheat depends largely on the proper and efficient preparation of the land and that canal irrigation does not necessarily injuriously affect the milling qualities of wheat. It is expected that great consequences will result from these investigations and that they will be the means of opening a new chapter in the production of wheat in India and in the agricultural practices of the Indo-Gangetic plain.

The Monograph on Indian Wheat has been published during the year. While going through the press, it was necessary to add a considerable amount of new matter so as to bring it up to date. The book represents the results of the preliminary work on wheat which has been done at Pusa during the last four years and will, I trust, be of use to students and some members of the Agricultural Department.

The investigations on the natural crossing of wheat in India have been written up and incorporated in a memoir.

It has been proved that under canal irrigation in the Punjab, crossing is exceedingly common, a fact which will render seed distribution and wheat breeding work at Lyallpur somewhat difficult.

Many of the new Pusa selections and also some of the new hybrid wheats were grown on quarter acre plots at Pusa this year. As no rain fell during the growing period and as no irrigation water was applied, the crop derived its moisture from the water stored up in the soil from the previous monsoon. The yields varied from 25 maunds in the case of early varieties to 35 maunds per acre in the case of the later sorts and some of the new hybrids. About 2·5 tons of straw to the acre were produced. These yields are unprecedented for India and were possible on account of the system of cultivation and dry-farming employed in the Botanical area at Pusa.

Fruit.—The results so far obtained in fruit-growing at Pusa have been published in Pusa Bulletin No. 16. A visit was paid to Quetta during the year and proposals have been put forward for developing the fruit investigations of the section.

Tobacco.—The results of the tobacco investigations have been published in two memoirs on the subject which form a basis for further work. Natural crossing is common in the crop but easily prevented by raising seed under bag which gives rise to uniform crops. Some preliminary curing experiments have been conducted in conjunction with the Peninsular Tobacco Company with both American and Indian varieties. The Pusa varieties have given the best results so far.

Fibres.—A good deal of work has been done on *Hibiscus cannabinus*, but I have been unable to find time to write up the results. A memoir on *san* (*Crotalaria juncea*) has been published in which the beneficial effect of this crop as a green manure for tobacco has been described.

General.—A large amount of work on the occurrence of natural cross-fertilization in India has been written up

as a memoir and submited for publication. The significance of this work both from the point of view of plant breeding and from that of seed distribution has been emphasised.

Programme of work for 1910-11.—1. *Training.*—The training of advanced students in this section will be continued on the lines laid down in the prospectus of the Institute. The course on fruit-growing will be given as usual in the cold weather.

2. *Plant breeding and plant improvement.*—During 1910, the following crops will be studied :—wheat, tobacco, barley, oilseeds and fibre plants.

(*a*) *Wheat.*—The botanical survey of the wheats of Baluchistan will be completed. The production of improved varieties by selection and hybridization will be continued. The co-operative experiments on the effect of environment on the milling and baking qualities of Indian wheats, which are being conducted in collaboration with Mr. H. M. Leake, Economic Botanist to the United Provinces, and of which the earlier results are now in course of publication, are being continued on an extended basis. The above experiments include the effect of weathering on the quality of the wheat crop and the Imperial Bacteriologist has agreed to undertake the study of the bacteriological aspect of this subject.

(*b*) *Tobacco.*—The production of new varieties by selection and hybridization will be continued as well as the testing and curing of the varieties already isolated. The investigations on the influence of environment on the stability of the type and on the quality will continued.

(*c*) *Oil-seeds.*—The study of the oil-seeds of India will be continued on similar lines to those adopted in the investigations on wheat.

(*d*) *Fibres.*—The isolation and testing of pure races of the fibre plants of India will be continued.

(*e*) *Fruit.*—The fruit experiments will be continued on the lines laid down in the First Fruit Report.

(*f*) *Minor Investigations.*—The study of the varieties of cassava will be completed and the investigation on the inheritance of sex in *Ganja* continued.

Publications.—The following books and papers have been published and written during the year :—

Report on Economic Botany for the Board of Scientific Advice, 1909 (in the press).

The Milling and Baking Qualities of Indian Wheats, No. 2. Some new Pusa Selections tested in 1909 (with G. L. C. Howard). *Bulletin No. 17 of the Agricultural Research Institute, Pusa.*

Second Report on the Pusa Fruit Experiments, *Bulletin No. 16, Agricultural Research Institute, Pusa.*

The Fertilising Influence of Sunlight (with G. L. C. Howard). *Nature,* February 17th, 1910.

Studies in Indian Tobaccos. No. 1. The types of *Nicotiana rustica* L. Yellow-flowered tobacco (with G. L. C. Howard). *Memoirs of the Imperial Department of Agriculture* (*Botanical Series*), Vol. III, No. 1.

Studies in Indian Tobaccos. No. 2. The types of *Nicotiana tabacum* L. (with G. L. C. Howard). *Memoirs of the Imperial Department of Agriculture* (*Botanical Series*), Vol. III, No. 2.

Studies in Indian Fibre Plants. No. 1. On two varieties of *Sann, Crotalaria juncea,* L. (with G. L. C. Howard). *Memoirs of the Imperial Department of Agriculture* (*Botanical Series*), Vol. III, No. 3.

The Influence of the Environment on the Milling and Baking Qualities of Wheat in India. No. 1. The results of 1907-08 and 1908-09 (with H. M. Leake and G. L. C. Howard). *Memoirs of the Imperial Department of Agriculture* (*Botanical Series*), Vol. III, No. 4.

The Economic Significance of Natural Cross-fertilization in India (with G. L. C. Howard and Abdur Rahman Khan). *Memoirs of the Imperial Department of Agriculture* (*Botanical Series*), Vol. III, No. 6 (in the press).

Wheat in India, its varieties, production and improvement (with G. L. C. Howard). Published by Thacker, Spink and Company, Calcutta.

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST, FOR THE YEAR 1909-10.

(J. Walter Leather, Ph.D.; F.I.C.; F.C.S.)

Charge of Section.—Mr. H. E. Annett, B.Sc., M.S.E.A.C., Supernumerary Agricultural Chemist, was in charge of this section until October 27th when I returned from leave.

Meteorology.—In addition to the usual temperature, humidity, etc., records, an evaporimeter has been constructed and the data will prove of service to both the Meteorological and Irrigation Departments. The first instrument employed, a self-recording one, proved to be defective, chiefly because the atmospheric dust of the hot weather accumulated in the working parts. A much simpler and quite reliable instrument was kindly supplied to me by the Chief Engineer, Punjab Irrigation Branch, and reliable data can now be obtained, though the record is not self-maintained.

Drainage data.—The records of drainage under conditions of both bare-fallow and cropped soil at Cawnpore and Pusa are now bearing fruit and the first few years' results will be put together for publication at the close of the present monsoon. In addition to the quantities of water which percolate, evaporate or run off the land respectively, information regarding the period of most active nitrification, as also the effect of crops on nitrification is being gleaned. This subject is not entirely novel, M. Dèherain having published information in respect of it some 15 years ago, but it has not generally been acknowledged as important. The crops, wheat and maize, which were grown on two of the Pusa gauges, depressed in some way or other the formation of nitrates last year very materially.

Water requirements of crops.—The first section of this investigation was published during the year as Memoir

No. 8, Chemical Series, and dealt with both the total amount transpired as also the period during which the greater part was assimilated. The effects of temperature and humidity, proportion of water in the soil, manure, the nature of the crop, etc., were dealt with. One of the most important of these is manure, which whilst increasing the weight of the crop and consequently the amount of water required, effects an economy of the latter since the increased requirement of water is proportionately less than the increase in crop. Good tillage probably has a similar property. The second section of the investigation has to do (*i*) with the effect of different soils and (*ii*) with the results of field tests; this will be published shortly.

Soil Gases.—The first section of work in connection with the subject of soil gases dealing with the relations of carbonic acid to calcium carbonate and water, has been published as Memoir No. 7, Chemical Series, and it is expected that a second section dealing with the similar relations to magnesium carbonate will be published in the course of the cold weather.

Usar land.—At the request of the Deputy Director of Agriculture, Central Circle, United Provinces, an investigation into the nature of some land which has been going out of cultivation in the Mainpuri District, has been commenced and has indeed absorbed so much time that no less than three or four of the assistants are at present utilised for it.

The soil is Usar, of the "black alkali" type, but the amount of alkali present was thought at first to be too small to account for the sterility. The sub-soil water level has risen seriously of late years and no doubt was felt that this was one of the primary causes of the trouble. But in addition to this, preliminary tests showed that the soil is so highly impervious to water that this feature alone might account for sterility. All, or at least nearly all, the water assimilated by plants must move through a certain amount of soil before it comes in contact with the root; such distances may only be a few inches or centimetres,

but this feature of the process must nevertheless be recognised; and if the amount of water moving to the root in a given time is too small for the nourishment of the plant, there may be abundance of water in the soil, and yet unable to reach the roots sufficiently quickly; the plant's energy would thus become reduced, and the crop might die off altogether.

There were thus three distinct questions involved, namely, (*i*) the high sub-soil water level, (*ii*) the alkali in the soil, and (*iii*) the impervious nature of the soil. The investigations which are being conducted at Pusa have to do with Nos. (*ii*) and (*iii*) of these questions.

In order to study the subject in the field as far as possible, Mr. S. C. Kar, M.A., the second assistant, was deputed to work under the instructions of Mr. B. C. Burt, Deputy Director of Agriculture, United Provinces, at Bhadan, where a temporary laboratory was fitted up. Here the amounts of alkali and water were determined in the soil at specific points, in every 6 inches depth down to 7 feet or 8 feet from the surface, until the middle of May, when this part of the work was transferred to Pusa. In addition to an estimate of the amount of salts in these soils, it was especially desired to ascertain the amount of their upward movement during dry weather or their downward movement during the rains. But since no two tests can be taken in exactly the same place and since further it is known that the amounts of such salts vary considerably within comparatively short distances in the lateral direction, it became necessary to determine this latter, as an adjunct to the former feature. Such an investigation involves more work than might appear necessary at first sight and the whole series of tests are not yet complete, but it has become abundantly evident that (*i*) the amount of variation laterally is, as was anticipated, comparatively large, and (*ii*) that in these soils the amount of upward movement of salts to the surface during the dry weather is only nominal. This latter feature is quite in accord with expectation; the amount of salts brought to the surface

will depend largely on the amount of water moving upward; if the soil is highly impervious to water, such movements will be very limited; and consequently the amount of salts brought to the surface must likewise be limited. There was hardly any upward movement of water, and accordingly there could be no material concentration of salts at the surface.

The soil being so highly impervious to water, it became of first importance to try to measure this characteristic. By an improvement of a method originally suggested by Mr. Milton Whitney of the United States Department of Agriculture, a mechanical test has been devised, by the aid of which very interesting information has been obtained regarding the rate at which water can move through the Mainpuri as also through other soils. Thus for example, the Usar land in the Mainpuri District which we have been examining, is highly impervious as far down at least as the samples were drawn; the Juhi Usar reserve near Cawnpore is similar to a depth of 5 feet after which it is quite pervious to water; other sterile spots of land have proved to be quite pervious to water, and their sterility must be due to other causes.

In addition to these lines of investigation an exhaustive series of pot-cultures has been commenced at Pusa in order to ascertain whether the defective physical state of the Bhadan (Mainpuri) Usar soil can be remedied or reduced; and if this change were effected, whether the amount of alkali is itself sufficient to cause sterility; also what plants will grow most readily under such adverse conditions.

Finally, in addition to work on the Bhadan soil, the Usar land which has been wholly or partly reclaimed near Aligarh, by the Department and by Mr. Keventer respectively, is being examined in order to ascertain what changes have taken place during the period of years that the work has been in progress.

General Analytical Work.—The number of samples sent for analysis has remained, as in the preceding year,

much smaller than it formerly was. Most of the Provincial Departments are now able to execute all such work for themselves, and assistance in this respect has only been asked for from three provinces. The major part of the remaining samples has been submitted by the officers in charge of the Military Farms, who require opinions on soils and on grasses and other feeding stuffs.

Education.—One student from the Punjab took a short elementary course of Chemistry. One of the assistants of the Agricultural Chemist, United Provinces, is taking a three months' course. In addition, two new assistants on the ordinary establishment have been entertained, and these, as in all such cases, have been largely in the position of students.

Establishment.—The changes involved have been due (*i*) to a junior assistant not being confirmed and another appointed in his place, and (*ii*) to the temporary appointment of a graduate of the Bombay University to act during the absence of other members of the regular establishment. The latter case is of interest, because although this assistant is an M.A. graduate with very good credentials, he was willing to come for a purely temporary acting appointment on Rs. 50 and thereby try to learn something. The other assistant who was appointed during the year, worked purely as a volunteer for about a year in Mr. Hooper's laboratory at the Indian Museum, and has proved an excellent assistant. It is this class of man that deserves most encouragement and likewise generally makes the best public servant; young men who are willing in the first instance to show that they are capable of doing useful work rather than to sit down and do nothing until a highly paid appointment turns up.

Programme of Work for 1910-11.—1. The work on the availability of plant food in soils will be continued, the immediate aim being the more correct ascertainment of the composition of the aqueous solution in the soil. Included in this section of investigation are naturally the amounts of nitrate in soils and soil temperatures.

2. The investigation on soil moisture and water requirements of plants is being continued on lines which have been sufficiently indicated in the memoirs.

3. A joint investigation with Mr. Burt, Deputy Director of Agriculture, United Provinces, is being conducted into the causes of infertility in a tract of land in the Mainpuri District.

4. The effect of soil and manure on the composition of crops is a branch of study which is engaging the attention of a number of investigators and is one on which I have already obtained some information. It will be developed, if possible, at Pusa during the coming year.

5. Two points in relation to the Indian saltpetre manufacture, in respect of which it seems possible that an improvement can be suggested, will be investigated.

6. *Education.*—This requires no special comment; it will be conducted according to the lines laid down.

Publications.—The following papers have been published :—

Memoir No. 8, "The Water Requirements of Crops in India" by Dr. J. Walter Leather.

Memoir No. 9, "The Nature of the Colour of Black Cotton Soil" by Mr. H. E. Annett.

REPORT OF THE IMPERIAL ENTOMOLOGIST, FOR THE YEAR 1909-10.

(H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.)

Charge and Establishment.—The Imperial Entomologist held charge of the section during the year. The Supernumerary Entomologist, Mr. C. W. Mason, left the Department on December 19th and Mr. T. Bainbrigge-Fletcher, R.N., F.E.S., joined the Department as Supernumerary Entomologist on the 8th April. The first assistant, Mr. C. S. Misra, who has absent on privilege leave from the 4th May to the end of June, had charge of the students, of the field-work on the Pusa Farm and Botanical area and of the work with lac culture. Apart from the courses of lecturing given by the Imperial Entomologist personally, Mr. Misra has carried out the field and practical instruction of students, which he has done admirably, and also one of the two short courses of instruction given in lac culture. The second assistant, Mr. C. C. Ghosh, has had charge of the insectory and carried out all inquiries conducted there. His work has been of the very greatest utility; he has also been able to prepare a Bengali revision of Indian Insect Pests which has been published. The third assistant, Mr. G. R. Dutt, who was absent on privilege leave from 1st November 1909 to 31st January 1910, has been in charge of economic records, correspondence and collections and has done original work on *Aculeate Hymenoptera.* In spite of his heavy routine work he has found time for both original enquiry and for the compiling for publication of a list of the vernacular names of insects, which is being published. Mr. D. Nowrojee has been in charge of the general collections and has done excellent work in their upkeep and arrangement. The post of Sericulture Assistant, which was filled up by Mr. L. M. Dass, is now held by Mr. R. R. Ghose. The Bengal Entomological Assistant worked in the laboratory for some

months, pending the provision of accommodation at Sabour; the artist staff of the Institute also worked under the direction of the Imperial Entomologist from September to January. The Baroda Entomological Assistant spent a fortnight in Pusa discussing his year's work and the programme for next year.

Training.—The full course of Entomology was given to students from Madras, Central Provinces, Bengal and the United Provinces. It is to be regretted that no students have been sent for the course commencing on June 1st, 1910. A short training, as part of the course in general agriculture was given to a student from the Punjab. The short courses in Eri Silk cultivation have been taken up by 15 students from different parts of India and by boys sent by the United Provinces Agricultural Department. Irregular training in rearing has been given to a number of rearers from Indigo factories, zemindars, etc., who were taking up the industry. The courses in lac have been taken up by 10 students from Lucknow, Hyderabad, Bettiah, Dacca, Cuttack, Jullundur, Rajkot, Jodhpur and Gaya and three *malis* were trained for employment in lac-work in Behar.

Provincial work.—The number of assistants employed in Entomological work in the Provincial Agricultural Departments is now 16 : 5 for teaching, 11 for field work. This number is wholly insufficient to bring the practical work of Entomology before the agricultural classes, but in the absence of Entomologists in the Provincial Departments to direct their work, the number is not being increased. It is something that applied Entomology forms part of the course of training at five Agricultural Colleges, but it is too much to expect eleven field-assistants to make any progress with showing how crop pests can be checked. As in previous years, the assistance offered in directing and checking the work of these assistants has been utilised by some provinces and the more technical work has been referred to Pusa, leaving the assistants free to do field work entirely. In Madras, the study of the destructive insects

has been continued on the lines laid down in 1906, and very substantial progress has been made; the pests have been carefully studied in almost every district and the preliminary work of collecting information on the spot materially advanced. Good work has been done against the Hairy Caterpillar pest in South Arcot and against the Deccan Grass-hopper which appeared in the Northern Division. In Bombay, very successful work has been done against the Rice Grass-hopper; the Potato-moth and Deccan Grass-hopper are being worked at where they occur and the work should bear fruit this year. Proposals have been made for putting the Entomological work on a better footing and placing it under the general direction of the Imperial Entomologist as in other provinces. In the Central Provinces, the success of the methods tried against Potato-moth has led to their adoption on a larger scale and a careful trial has been made of the trap-crop method of checking boll-worm of cotton on the farms. The cultivation of Eri silk has been experimentally taken up at Multai and Chanda. An investigation into termites in Hoshangabad has been started with the Deputy Director of Agriculture, Northern Circle, and the general pests of the province are being investigated. In Bengal, and Eastern Bengal and Assam, the general investigation of injurious insects has been continued; in the latter, the work against Potato-moth is likely to give good results. In the United Provinces, the work against the Cane Grass-hopper has been the principal item and the general investigation of injurious insects has been continued. The cultivation of Eri silk has been experimentally taken up at Cawnpore. In the Punjab, sericulture and bee-keeping have been experimented with and the general crop pests of the province investigated. In Baroda, good work has been done in inducing cultivators to take an interest in and adopt measures against the Hairy Caterpillar, the boll-worm and the *til* stem-borer, in addition to the usual cases of insect pests reported from various crops.

In general, the provincial work is preliminary and directed to ascertaining what are the pests of the province and how far they are destructive. Only in Madras is the work so far advanced that an accurate statement of the crop-pests can be prepared and a reasonable estimate formed of the possibilities of developing the work. In almost all provinces, progress has been made in coping with crop-pests as they occur in serious outbreaks, but in almost all the work requires systematising on a permanent basis that will conduce to steady progress and eventual thoroughness. Much advance cannot be achieved while the present staff in the provinces is limited to eleven assistants and the direction of the work is in the hands of various officers in the Provincial Departments who have other work to do and who do not want additional staff to look after.

Correspondence.—As in previous years, there has been a large volume of enquiries on all matters connected with insects; the enquiries connected with insects attacking crops have been mainly diverted to the Provincial Departments, but a large mass of miscellaneous enquiries has been received and dealt with. A part of these are from official sources, exclusive of the correspondence with Provincial Agricultural Departments, but a large part also is from the general public; they deal with garden and fruit pests, household pests, insects in grain and timber, insects on domestic animals, insecticides, spraying machines and the identification of insects. The parcels of injurious insects sent in numbered 117. A total of 1,255 enquiries came from official and public sources and at least as many again from planters and others in close touch with the section were answered demi-officially without record. The enquiries with regard to si'k numbered over 1,000 and there were many concerning bee-keeping and lac. So far as possible, these are answered by reference to publications, or by the despatch of a leaflet or reprint but they are of such wide range that a very large number must be answered fully and this occupies much time. I hold this work to be of very direct value and I believe every enquiry has been fully and promptly met to the best of our ability.

Research.—Progress has been made with enquiry into the life histories and habits of injurious insects. The more important have been the Palm-weevil, and Rhinoceros beetle, the Army worm, the Rice Swarming Caterpillar, the Deccan Grass-hopper, the Wheat Stem-borer, the Pink Boll-worm, the Indigo Leaf-webber, the Dusky Cotton Bug, Wheat weevil, Rice grain moth. A more careful enquiry into the white ant problem has been commenced partly at Pusa, partly at Hoshangabad in conjunction with the Deputy Director of Agriculture, Northern Circle, Central Provinces. In collaboration with the Imperial Agricultural Chemist, the enquiry was continued into the relation between weevil and the percentage moisture of wheat. The enquiry into the food of birds by Mr. C. W. Mason was brought to a conclusion and the results will be published. The new insecticide was thoroughly tested and is now on sale. An increasing number of patent insecticides have been referred here for trial and report; these have been tested and, with the check afforded by the analysis of the Imperial Agricultural Chemist, reported on as to their value for Indian conditions. Only one has proved to be of any value for this country and, with this exception, the insecticides introduced by this Department are those at present in use; arrangements are made for their sale and we maintain a register of the places where both insecticides and all patterns of spraying machines can be purchased, so that enquirers can be at once referred to the proper places. Until private enterprise finds this business worth taking up, the trial of insecticides and sprayers must be done here and arrangements made for their sale. The question of apiculture is still being considered and further attempts are being made to determine how far bees will thrive and be profitable in the plains.

Sericulture.—The cultivation of Eri silk was continued and all processes to the production of the finished cloth carried on. Three weavers, an average of twelve spinners and cleaners, and about fifteen rearers are constantly

employed and we endeavour to produce every variety of cloth that is likely to be made of this material. The course of training was given to 19 persons, mainly those who wish themselves to take it up as an industry or the employees of those who are commencing the industry. The Pusa Continuous Spinning Machine was perfected and arrangements made for its sale. Assistance was given to the inventor, Mr. R. W. Coryton, of a very ingenious machine for cleaning the cocoons prior to spinning and this machine is now being sold. Every process from rearing the worms to weaving the cloth is being conducted in the silk house, so that visitors can see and quickly understand the whole process. The demand for seed has been very large (in one month $2\frac{1}{2}$ million eggs were sent out) and arrangements were made for an exchange of seed between rearers in different parts of India, this section being the medium for effecting the exchange. Seed was supplied from Pusa to as many persons as possible, but the demand was far in excess of what could be supplied. Many hundreds of persons have given a trial to the industry and while many have, for the present, stopped owing to the absence of any means of disposing of small quantities of cocoons, many are continuing successfully. No attempt was made by this section to popularise or to draw attention to this industry except in Tirhoot, with the sole exception of the publication of an article in the Agricultural Journal of India; yet hundreds of enquiries have come in, from every part of India except Assam, and it is evident that, if there was the organisation to help, advise and buy small lots of cocoons, the industry could be taken up on a very large scale, affording light remunerative work to women and children which they take to readily. In Tirhoot, an attempt was made to induce the Behar Indigo Concerns to serve as buying centres for the hundreds of small lots of cocoons that were being offered but this has failed. Many Tirhoot rearers are still carrying on the industry in order to make and sell cloth but at the commencement all small rearers want to sell cocoons. The industry is establishing

itself, as centres for buying cocoons develop naturally and as the rearers take to making cloth. It is evident that the larger land-owners must take it up first and that the small cultivators cannot do so without some organisation to dispose of their products. It is also necessary at first to be in touch with Pusa or some other centre that can advise and help. The industry is most extensive at present in Tirhoot, Bhagalpur and Patna, the three divisions nearest to Pusa but is being tried also in Malabar, Dharwar, West Coast, Gujarat, Kathiawar, Sind, Patiala, Rohilkhand, Betul, Chanda and Murshidabad. The Salvation Army has also taken it up at Bangalore and elsewhere. Enquiries were made from silk spinning firms in England, France, Switzerland and Japan as to the value of Eri silk cocoons for industrial use there; one Indian silk spinning mill is spinning Eri silk yarn of fine counts, which is being used for weaving in India; but until there is some organisation for collecting and selling large quantities of cocoons, the industrial uses of this material cannot be developed. In this question, we have had the assistance of Mr. Drieberg of the Ceylon Agricultural Society, who is interested in the same problem. Trials are being made at Pusa with hybrids between *Attacus ricini*, the Eri, and *Attacus cynthiæ*, the wild form; these are not encouraging but may yield a more robust race. The disease of Eri worms which is occasionally a serious and inexplicable factor, is being investigated in collaboration with the Imperial Agricultural Bacteriologist and trials are being made of the various varieties of castor for feeding the worms.

Mulberry silk cultivation was continued mainly to determine how far it can be profitably taken up either to provide raw silk, or to supply cocoons. All available varieties have been collected at Pusa for hybridising. The rearing of the best Italian and French varieties has been very successful; the rearing of the ordinary Bengal varieties has shown that they are not worth cultivating in Behar, and the cultivation of a hybrid between the European univoltine worms and the Bengal multivoltine is

giving good results. The problem of increasing the supply of good cocoons for reeling is of very great importance and there is good reason to believe that very much better cocoons could be produced on a large scale if the industry were developed on the right lines. The experiments of the Bengal Silk Committee and those carried out at Pusa show that success is probable, but that it will take time and organisation to develop the supply and keep rearers on the right lines; failure in inevitable if the present Bengal varieties are cultivated as the silk is almost unsaleable and not worth growing and reeling in new localities. The present experimental work is very satisfactory and the very depressed condition of the silk industry fully justifies the employment of a proper staff to complete and develop these lines of improvement.

Lac.—The cultivation of the lac-insect on *Ber* (*Zizyphus Jujuba*), *Siris* (*Serissa glomeruta*), etc., has been carried on as before and two short courses of training were given to ten students from Bengal, Hyderabad (Deccan), the Punjab, the United Provinces, Kathiawar and Jodhpur, as well as to *malis* from factories in Tirhoot. Lac for seed was supplied to the Bombay and Baroda Departments of Agriculture, to a Court of Ward's Estate in Orissa and arrangements have been completed for forwarding the same to Formosa through the Japanese Consul at Bombay. The most important work of the past year was an enquiry into the races of the lac insect in collaboration with the Forest Department which sent in samples from all parts of India and Burma. The samples are being collected, arranged and forwarded to Mr. E. E. Green, the Government Entomologist, Ceylon, for examination. The number of enquiries regarding lac cultivation in India increased considerably and every assistance was given to those wishing to start it on waste lands in agricultural areas.

Demonstration.—The series of coloured plates of pests has been added to and copies circulated to all Provincial Departments, to the Bombay Natural History Society, the Quetta Museum, the Madras Museum, the Bishop Cotton

School, Simla, the Indian Gardening Association, Calcutta, the Central Agricultural Committee of Madras, the Ceylon Agricultural Society, Colombo, Department of Agriculture, Baroda State, Mycologist and Entomologist, Mysore State and the Director, Educational Section, United Provinces Exhibition, Allahabad. These plates are being utilised in demonstration in all provinces and in vernacular and other publications in Bengal, Eastern Bengal and Assam, Bombay, the United Provinces and the Central Provinces. They are also used in preparing show cases of crop pests for exhibitions, shows, farms, etc. Sample show cases have been prepared and sent out; all Entomological Assistants have been trained in preparing them and it is now only necessary to complete the series of plates to cover all crop-pests, beneficial insects and such useful insects as silk, lac and bees. Trials are being made of coloured lantern slides of these plates to enable lectures to be given at agricultural shows, etc. Assistance was given in preparing show-cases and exhibits for the agricultural section of the Lahore Exhibition and a working exhibit of Eri and mulberry silk was sent to the Muzafferpur Exhibition.

Insect Survey.—Less time has been given to the work with the general collection, only new accessions being placed and arranged. The students' working collection has been very much added to. Collections have been sent away for the use of authors of coming volumes of the Fauna of India. These include the *Collembola, Orthoptera, Mallophaga, Braconidæ* and *Ichneumonidæ, Neuroptera, Odonata, Dynastidæ, Rutelidæ* and *Cetoniidæ, Cantharidæ, Curculionidæ, Microlepidoptera, Thysanoptera, Rhynchota, Heteroptera* and *Homoptera.* Further collections were identified and arranged for the Bombay Natural History Society, and specimens were identified for private collectors, for the Madras Museum and the Quetta Museum. Similar collections were made up and identified for Provincial Agricultural Colleges and a large mass of identified material is available for distribution.

Miscellaneous.—The Imperial Entomologist is President of the Entomological Section of the Bombay Natural History Society and lectured to the Society in September. All entomological enquiries sent to the Society are referred to him and insect specimens sent in for identification are referred to Pusa. The Imperial Entomologist also acted as Chairman of the Indian Sub-Committee of the International Congress of Entomology to be held at Brussels in 1910. An exhibit illustrating the work of the section was sent to the delegate for India, Mr. F. M. Howlett, Second Imperial Entomologist. Assistance has been given to the Government of Japan in regard to Eri silk and lac and the latter insect is being introduced into Formosa. The improvements made in the treatment of Eri silk have been communicated to the Ceylon Agricultural Society. Parasitised cotton boll-worms were sent to Ceylon and Egypt to introduce the parasite; live Eri cocoons were sent to Ceylon, China and Formosa, and live tussur cocoons to Egypt; Eri cocoons were also sent to England and France, the former in order to be crossed with *A. cynthia*, to improve the race. In exchange, *cynthia* cocoons were received at Pusa for the same purpose.

Programme of work for 1910-11.—The work of the past in studying and advising on crop-pests will be continued. Assistance will be given, when desired, in directing the work of provincial assistants, in coping with outbreaks of crop pests and in organising exhibitions for agricultural shows. Assistance is being given in the entomological exhibits at the Allahabad Exhibition. The issue of coloured plates is being continued and coloured lantern slides for lectures will be issued for trial. Further work on apiculture will be done and the short courses of instruction in Eri silk, mulberry silk and lac continued. The progress of the Eri silk industry will be assisted specially with a view to finding foreign markets and to the using of the material for products required in India. The question

of growing better races of mulberry silk for supply to the Bengal filatures will be further tested and the general question of improving the silk industry investigated.

Publications.—The edition of Indian Insect Pests is exhausted and the progress for the last four years makes a new edition necessary. A revision up to June 1909, has been translated into Bengali by the second assistant, Mr. C. C. Ghosh, and published in Calcutta. Applications for permission to publish other translations have been referred to the respective Provincial Departments as a revision of the text is required and the staff at Pusa cannot translate into all vernaculars. "Indian Insect Life" has been issued and is now available for all students and workers in Entomology. A list of other publications is attached. This is smaller than it might be, but the time has not been available for preparing more and the issue of these has entailed much work that should not fall on the staff of this section.

PUBLICATIONS.

Indian Insect Life. (Text-Book.) September, 1909.

Fasaler Poka. (Text-Book.) September, 1910.

Lac as an Agricultural Product. (Agri. Journ. Ind.) July, 1909.

A New Insecticide. (Agri. Journ. Ind.) April, 1910.

Weevil in Wheat. (Indian Trade Journal.) November 18, 1909.

Fauna of Tirhoot I. Rhynchota. (Ind. Mus. Records.) December, 1909.

Storage of Potatoes. (Agri. Journ. Ind.) January, 1910.

Thrips in Tea in Darjeeling. (Agri. Journ. Ind.) July, 1909.

Instructions for rearing Eri Silk. (Leaflet in English, Hindi, Bengali.) January, 1910.

Eri Seed Exchange. (Leaflet.) January, 1910.

Life-Histories of Coleoptera. (Memoir.) January, 1910.

Vernacular Names of Insects. (Bulletin in press.)

Tukra Disease of Mulberry. (Agri. Journ. Ind. and Bengal Agricultural Journal.) April, 1910.

Three Journal Reviews.

REPORT OF THE IMPERIAL MYCOLOGIST FOR THE YEAR 1909-10.

(E. J. Butler, M.B., F.L.S.)

Charge and Establishment.—Mr. W. McRae, M.A., B.Sc., Supernumerary Mycologist, held charge of the Section until December 27th, 1909, when I returned from leave. Mr. McRae joined his new appointment as Mycologist to the Government of Madras immediately after; his loss was much felt, but he has taken charge of mycological work in a province which is second to none in India in the number and magnitude of its fungus diseases of plants. His successor, Mr. F. J. F. Shaw, B.Sc., A.R.C.S., joined his appointment on January 28th, 1910. The vacant post of first assistant was filled by Mr. J. F. Dastur, B.Sc., on May 14th, 1910. Mr. J. H. Mitter, second assistant, was appointed Assistant Professor of Mycology in the Punjab Agricultural College, Lyallpur, from June 1st, 1910. The remaining members of the laboratory staff have each received promotion as a consequence. All have done good work. Messrs. J. H. Mitter and S. N. Mitra have given material assistance in the training of students and in general laboratory work; the latter, Mr. A. Hafiz Khan and Munshi Inayat Khan in field work and on tour; while Mr. Hafiz Khan, by his keenness and capacity for independent research is proving a valuable assistant. In Munshi Inayat Khan we have one of the most useful types of native botanical assistants; without any English education, he has yet an almost phenomenal knowledge of indigenous plants gathered during long service under Mr. Duthie in the Saharanpur Herbarium and as a collector in all parts of Northern India. He is in charge of the herbarium and collections, which are well kept up. The Bengal Mycological Assistant worked in the laboratory pending the provision of accommodation for him at Bhagalpur, until April 14th, 1910.

2. *Training.*—Nine students in all received instruction during the year. Of these two were second year students undergoing the full course. Their training ended on March 31st, 1910. Three were members of the Punjab Agricultural Department and received elementary instruction as part of a general agricultural course. As the Provincial Colleges are now in a position to teach elementary mycology, it is not expected that any more students of this class will be received. The student under training as Mycological Collector for Eastern Bengal finished his course on March 2nd, 1910. A Forest Ranger was deputed from the Punjab for an elementary training in the diseases of fruit and forest trees, and a private student from Oudh received a short course in fruit and vegetable diseases. Only one student (private) joined for the full two years' course at the beginning of the new term, June 1st, 1910, and he has since abandoned it. The three senior students took up about half my time in January, February, March and June, chiefly in the preparation of the lectures.

3. *Accommodation.*—The capacity of the general laboratory for students and assistants has been taxed at times, especially when several have been simultaneously engaged in original work. For a time eleven were working in the one room, which is too many for the space available. A portion of the clerk's room has been fitted to relieve pressure in the laboratory. The chief requirement at present is a small outside room with enclosure attached for inoculation and pot-culture experiments. The herbarium has been largely added to (364 named sheets), and has ample space for subsequent expansion in a room on the 1st floor. Improvements were made in the sterilising and culture rooms.

4. *Aid to Provincial Departments.*—Collections of named fungi, chiefly parasitic, have been furnished to the Madras, Punjab, Bengal and Eastern Bengal and Assam Departments. Duplicate collections made in Bombay and Burma have been identified as far as possible and the determinations forwarded to these Departments. This work

will be continued so as to provide a nucleus for a mycological herbarium in every provincial college. The detailed syllabus for an elementary course of lectures and practical work in Indian Mycology, drawn up last year, is being utilised as a basis for the mycological instruction in several colleges. The recommendation of the Board of Agriculture of 1908, that each province should have at least an Assistant Professor of Mycology and one other assistant is being worked up to fairly well. Besides Madras, which has now its own Mycologist, Mr. McRae, with one scientific assistant, Bengal, Bombay and the Punjab have each an Assistant Professor of Mycology attached to its college, the two former having a Mycological Assistant as well. The Central Provinces College has a Mycological Assistant, and Eastern Bengal a Mycological Collector. All these, except the Bombay Assistant Professor, have been trained at Pusa.

5. *Research Work. Blister Blight of Tea.*—This was the most important new work taken up during the year. The disease, which has been known for years in North-East Assam appeared for the first time in Darjeeling in 1908. In 1909 it extended, and the Darjeeling Planters' Association asked for the assistance of Pusa. Mr. McRae spent a considerable time in a local investigation of the blight. The life-history of the fungus (*Exobasidium vexans* Massee), before imperfectly known, was fully worked out and an extensive series of experiments on remedial measures undertaken. As a result of these, definite recommendations were made for the cold weather of 1909-10 and general measures for the control of the blight advocated. The results of the work were communicated in two reports to the Darjeeling Planters' Association, by which body they were printed for circulation to the planters concerned. In the present season, the blight is continuing to spread and already threatens the Dooars and Terai. Its progress will be watched with great anxiety by all interested in tea. It is feared that the climatic conditions prevalent in these districts will induce

greater virulence than anything known in Assam, but this will not be known with certainty until the close of the present or perhaps another season. A popular account of the disease is given in the Agricultural Journal of India for April, 1910, and a fuller report is in the press as a bulletin.

Other Tea Diseases.—Mr. Shaw is engaged in the study of the obscure canker of tea, which has long been known but the cause of which is still not ascertained. A disease of tea seed was investigated, but the cause was not definitely discovered.

Palm Disease.—The campaign having as its object to prevent the spread of the bud-rot of palms on the East Coast and to stamp it out within the affected area was prosecuted with energy by the executive officer in charge, Mr. W. K. Green, Special Deputy Collector, Godavari District. I accompanied Mr. McRae, to whom the scientific control has now passed, and Mr. Green on a short tour of inspection early in the present year. Recommendations for continuing the work have been made, especially for its energetic prosecution in Kistna District, where it has been neglected in spite of repeated warnings. Mr. Green was put in charge of work in Kistna as well as in Godavari from January last and this led to better work. A full account of the disease and measures taken to check it is in the press as a memoir. Mr. McRae enquired into a disease of palms at Bapatla in December but found it was not fungal. The coconut root disease in Travancore mentioned in last report is engaging the attention of the newly started Agricultural Department of that State, and measures have been taken on the lines suggested to prevent its spread. The cultivators of neighbouring districts have been warned through vernacular pamphlets of the danger of introducing certain coconut produce from Travancore.

Sugarcane Diseases.—The work in connection with these has not yet reached the stage of publication. Field experiments on the methods of infection of red rot having developed unexpected difficulties, it will probably be neces-

sary to continue in pot culture. Nothing has occurred to shake the opinion advocated by this section that it is primarily a disease conveyed in the sets and it is encouraging to report that scarcely a trace of it could be found at Samalkota Farm in the last crop. Similarly at Pusa there is ordinarily little, except near where the inoculation experiments are in progress. These results are believed to be due almost entirely to the methods of set selection recommended in 1906. There is, however, a good deal still to be elucidated. The life history of three undescribed sugarcane parasites has been in great part worked out. One causes a root disease in certain varieties of cane at Samalkota; its study has been carried out chiefly by Mr. Hafiz Khan, who has also investigated a leaf disease at Pusa. The third is prevalent in Behar. Work on sugarcane smut was continued.

Wilt-Diseases.—The results of the work of several years on the wilt disease of pigeon pea were issued as a memoir early in 1910. No opportunity arose for the study of other field crop wilts still awaiting investigation. In November, Mr. McRae visited the Wynaad at the request of the United Planters' Association of Southern India to investigate the pepper-vine wilt. He was accompanied by Mr. R. Anstead, Planting Expert to the Association, in conjunction with whom a scheme of experiments in the treatment of the disease was drawn up. As the cause, and indeed the whole history of this disease are still obscure, little advice of real value to pepper planters can be given as yet.

Ginger rot.—The investigation of this disease, caused by *Pythium gracile*, was continued by Mr. McRae, who visited Rangpur, Eastern Bengal, twice during the season. It is the principal trouble connected with ginger growing in this district and in Gujarat. It is hoped to publish an illustrated account shortly, with suggestions for treatment. Experiments so far appear to indicate that it is possible to check it by careful seed selection and rotation.

Fruit Diseases.—The survey of diseases of temperate fruit trees in India, was continued, chiefly from material

collected in Kashmir in 1908. Wither tip of citrus trees occurred at Pusa and experimental treatment was carried out. Other citrus diseases are under study at Pusa. A papaya disease which has killed a number of trees at Pusa was studied by one of the students and Mr. Mitra, but the work is not yet ready for publication.

Forest Tree Diseases.—As usual a number of these were investigated for the Forest Department and other persons. The chief of interest was *Fomes lucidus*, a probable parasite of several valuable trees including *Shisham* (*Dalbergia sissoo*) and Areca palm. An illustrated note on this was written for the "Indian Forester." The well-known parasite of the Himalayan blue pine, *Trametes Pini*, was discovered for the first time attacking deodar near Simla. Mr. Hafiz has been occupied in an attempt to determine the manner of spread of this fungus from specimens forwarded by the Imperial Forest Botanist.

Other Plant Diseases.—Two diseases caused by species of *Phytophthora* were investigated by the senior students under supervision. The life history of *Phytophthora Colocasiæ* was worked out. The other, which attacks seedling castor, appears to be undescribed previously. The work will be published after some further necessary study. Several cases of disease of important crops caused by the root-rot fungus, *Rhizoctonia*, were studied. Jute, potato, linseed, tomato, brinjal, castor and some pulses are amongst the plants attacked by this fungus, the existence of which in India has only recently been ascertained. An illustrated account of the leaf spot of turmeric, due to a new species of *Taphrina*, has been prepared for publication. Specimens of rice bunt, caused by *Tilletia horrida*, were received from Germany, on rice said to be of Indian origin. As this disease has only been reported from Japan and the Southern States an enquiry is being made as to its possible occurrence in India, especially Burma. The disease of

Para rubber trees due to *Corticium javanicum* was reported from estates in South India. Other rubber tree diseases were received from Burma. The examination of and reporting on these and many other diseases of crops and economic trees formed a large part of the routine work of the section.

Systematic work.—This was prosecuted as time allowed but the progress made was small owing to pressure of other work. As the demands from the Provincial Colleges for correct determination of their parasitic and other fungi are increasing, it is hoped to give more time to the subject than has been possible recently.

Miscellaneous.—Eight show-cases illustrating characteristic fungus diseases of plants were prepared for the Lahore Exhibition and six for the Bengal Department to exhibit at shows. Suggestions were made for regulations for the control of the importation into India of plants or parts of plants likely to introduce dangerous fungus diseases. Mr. Shaw assisted the Imperial Bacteriologist in the laboratory work in connection with Eri silk-worm disease.

Programme of work for 1910-11.—It is proposed to resume the work on soil fungi if time allows.

The work on the wilt diseases of crops, especially of indigo and cowpea and, if opportunity occurs, of cotton, gram and sesamum, will be continued.

The investigation of sugarcane diseases is being continued and the new results will be published.

It is hoped to obtain more information regarding the occurrence of *Rhizoctonia* on the crops mentioned above and to investigate its life history and treatment.

The study of the diseases of papaya, castor, colocasia and rice mentioned above, of tea canker and of heart-rot of blue pine will be continued.

The study of some anthracnoses of pulse crops will be continued.

It is hoped to work through another portion of the collections and to publish the determinations.

The training of students in Mycology will be continued. No student is taking the full course this session.

PUBLICATIONS.

Fomes lucidus (Leys) Fr., a suspected parasite. E. J. Butler. Indian Forester, September 1909.

The Wilt disease of Pigeon Pea and the Parasitism of Neocosmospora vasinfecta Smith. E. J. Butler. Memoirs of the Department of Agriculture in India, Vol. II, No. 9, January 1910.

The Outbreak of Blister-blight on Tea in the Darjeeling District in 1908-09. W. McRae. Agricultural Journal of India, Vol. V, Part 2, April 1910.

REPORT OF THE IMPERIAL AGRICULTURAL BACTERIOLOGIST FOR THE YEAR 1909-10.

(C. M. Hutchinson, B.A.)

The principal work of the Section for six months during which I have been in charge has been directed towards a general examination of the bacteria in the soils of Pusa. The scheme of work has resolved itself into :—

(1) Observation of occurrence and activity of bacteria at varying depths in the soil—

(a) with regard to varying species;

(b) with regard to their relations to soil chemistry.

(a) Determination of the species occurring in soils naturally involves a large amount of culture work extending over a long period of time, and has only been undertaken in consideration of the absence of information on this point so far as Indian soils are concerned. It is hoped that further experience gained in this way will enable a distinction to be drawn between those species whose widespread occurrence and activity makes them of importance from an agricultural standpoint, and others whose restricted development renders it unnecessary to study their characters from this point of view.

In addition to cultures made from samples obtained by boring, observations have been carried on periodically as to the bacterial content of soils in the Botanical Section especially those under experimental treatment by "weathering"; it is hoped that some light may be thrown upon the causes underlying the differences resulting from this method of dealing with soils.

The ordinary cultural methods of differentiation have been somewhat restricted by the impossibility of using gelatine owing to the high temperatures at Pusa in the

months of March, April, May and June. It is hoped that it may be found possible in the future to establish a hill station laboratory, where this difficulty may be eliminated during the hot season.

(*b*) The distribution and activity of the nitrifying organisms has been studied closely in samples taken from various depths and localities. The value of the information acquired has been considerably discounted by the contamination of some of the cultures owing to the absence of a suitable room for carrying out inoculations and withdrawing samples. During the dry hot months the air is charged with dust particles carrying innumerable bacteria and the periodical withdrawal of samples from the culture flasks is attended with great risk of infection of the latter, when conducted in the open laboratory. A suitable room, capable of being isolated from the general laboratory and kept free from dust and currents of air, was selected early in February, and arrangements are being made to have it converted for this purpose.

Active nitrification has been observed in borings from the plots attached to the pot culture house down to a depth of 24 inches, the greatest amount taking place in the second six inches. The samples were taken in February, when the dryness of the surface soil would naturally depress the general level of bacterial activity.

It is of interest to observe that salts of magnesia have been found to inhibit nitrification entirely in Pusa soils when the latter are seeded into liquid media. This effect is being further investigated with a view to determining its underlying causes. Samples have been obtained from borings to a depth of nine feet and it has been of interest to discover the relatively enormous numbers of bacteria present in the Pusa soils and their occurrence in the samples taken from the lowest depth, it having been found necessary to use dilutions of one in one hundred thousand in order to obtain a workable number of colonies in plating.

Some work has been done on nitrogen fixation in certain soil samples, but only of a tentative nature, fuller consideration of the subject being postponed until such time as my assistants have acquired more knowledge of bacteriological methods. It is proposed to make exhaustive enquiries into the distribution and characters of nitrogen fixing organisms in Indian soils, as it seems probable that this source of nitrogen is of prime importance and may even afford possibilities of control in actual practice, either by actually supplying such organisms to soils in which they are deficient, or, as the more hopeful means, by adopting methods of agricultural practice which would allow of the fullest development of those already naturally present.

Disease of Eri Silk Worms.—At the request of the Imperial Entomologist, a lengthy enquiry into the causes producing a very high mortality amongst Eri Worms has been undertaken, and is still in progress. The disease, the symptoms of which resemble those appearing in Flacherie of the Mulberry Worm, is associated with the presence of a bacterium, pure cultures of which have been made from the gut of diseased worms; attempts to establish the pathogenicity of this bacterium for Eri Worms, by feeding with leaf sprinkled with water shaken up with the cultures have so far failed to give decisive results. From enquiries made in Assam in the course of a tour undertaken with the object of enquiring into this matter, it appears that the disease, although known to native sericulturists, is considered due to defective feeding and management and not to be of the nature of an epidemic. Further experiments will be carried out with a view to determining the effect of varying food materials and feeding methods. Numerous sections of the intestine of normal and diseased worms were made by Mr. Shaw of the Mycological Section, showing the defective digestion characteristic of the disease and the development of the bacteria in the gut. These illustrate clearly the differences in the digestive processes incident to the disease, but it is not certain whether the increased number of bacteria is a cause or an effect of the

abnormal condition, although it appears probable that they contribute largely to the final result.

In connection with this enquiry, cultures were made from eggs of the Eri moth, which in many cases were found infected with a bacterium, differing however in cultural and morphological characters from that found in the gut of the diseased worms. Eggs of the same brood hatched out successfully forming healthy worms, but the next generation became diseased and died off. Further enquiries will be made as to the transmission of disease by inheritance.

The efficacy of Trope-Ratine, a patent vermin killer specially prepared for use in India, was tested at the instance of the Director. Rats fed on this material appeared to benefit from its nourishing qualities but were otherwise unaffected. One mouse, however, succumbed and was subsequently eaten by the rats without ill effects to the latter. It appears probable that the material had been kept too long since its preparation to retain its original virulence, a period of nearly five months having elapsed since its despatch from England.

I took over charge of the Section on 27th December 1909. As no previous establishment had been formed a Third Assistant was appointed, Mr. C. S. Rama Aiyer, previously acting as an assistant in the Chemical Section here. Subsequently in May, Mr. N. V. Joshi, who then held the post of an assistant under the Agricultural Chemist to the Government of Bombay, at Poona, was appointed as first assistant. The post of a second assistant is still vacant. Owing to the impossibility of obtaining qualified bacteriologists at the small rate of pay provided for this Section, I have been obliged to appoint men without any bacteriological qualifications; this necessarily results in most of my time being spent in training my assistants in the necessary technique, and this will of course retard the progress of the various investigations which, I hope, to carry out. Owing to the very special

nature of bacteriological research, a lengthy course of training and wide experience of the methods in use is necessary before any student can hope to do research work of any value on this subject, and I wish to record my emphatic opinion that in view of the admitted fact that adequate knowledge of the bearing of the biological factor on soil fertility is of prime importance in agricultural practice, it is highly expedient that the work of this Section should be facilitated by the addition of a trained Supernumerary to my staff.

Programme of work for 1910-11.—In addition to the work indicated in the following programme already submitted to the Board in February, certain special subjects for investigation will be taken up as occasion arises and opportunity permits. Of these, the further work necessary on the disease of Eri Silk Worms, and any special work on bacterial diseases of plants, will be leading features.

The Biological aspects of tillage in Indian soils.—This will involve investigations extending over a prolonged period, the basis of which would include a general investigation of the bacterial content of Indian soils.

Concurrently with this general investigation special observations will be made with the intention of determining the biological factors underlying certain problems of agricultural interest such as those connected with the custom of embanking wheat lands. They will also include enquiries into :—

(1) The biological aspects of the availability of plant food in soils.

(2) The biological factors concerned in the decomposition of organic matter in Indian cultivated soils.

(3) Biological aspects of :—

(*a*) Green manuring in India.

(*b*) " Weathering " of soils.

(*c*) Effect of ploughing land when too wet, before sowing.

No. (1) will be carried out in collaboration with the Imperial Agricultural Chemist, No. (2) in collaboration with the Imperial Mycologist, and No. (3) in collaboration with the Imperial Economic Botanist.

REPORT OF THE IMPERIAL COTTON SPECIALIST FOR THE YEAR 1909-10.

(G. A. Gammie, F.L.S.)

I held charge of the appointment throughout the year. From the 6th to the 9th July 1909, I visited Bombay to discuss work in cotton with some of the principal merchants there. From the 26th to the 28th July I visited Jalgaon to advise regarding the cotton section of the Exhibition to be held in the following January; from the 13th October to the 11th November I visited the Garo Hills, Dacca and Chittagong in Eastern Bengal at the invitation of the Agricultural Department; from the 12th to the 27th November I visited various parts of Bengal in company with the Economic Botanist with whom I discussed the future line of work to be conducted in his province. From the 28th November to the 7th December I was in the Central Provinces arranging matters with the Deputy Director of the Southern Division, from the 14th to the 16th December I met the Deputy Director of the Northern Division at Harda and settled with him the details of future trials in his division, from the 18th January to the 23rd January I visited the Farms of the Southern Maratha Country with Mr. Clouston, Deputy Director of Agriculture, Southern Division, Central Provinces, and Mr. Main, Deputy Director of Agriculture, Bombay. From the 26th January to the 5th February I attended the Jalgaon Exhibition where I took charge of the Cotton Section and discussed matters of interest with merchants and cultivators of Khandesh and Berar. From the 17th to the 21st March I visited places on the hill tracts of Belgaum and Dharwar to ascertain the progress of experiments with *buri* cotton. From the 1st to the 5th May I visited Cawnpur at the invitation of the Economic Botanist to advise regarding his experiments. From the 21st June till the end of the month I

toured with the Deputy Director of Agriculture, Bombay, and discussed minutely with him the results of the trials achieved so far by him.

The following are the notes and reports drawn up by me and they embody the information and impressions gathered on the more important aspects of the cultivation of cotton in the provinces :—

Eastern Bengal and Assam.—In company with Mr. Hector, I have completed an enquiry on the cultivation of cotton in the Garo Hills and Chittagong Hill tracts.

In a note on the subject of cotton by Mr. Hart based on his visit to the Chittagong Ginning Mill, he states that " one of the important problems to tackle is to find out (1) whether that of the Garo Hills is a better *jat* than those grown in the Chittagong Hill tracts or (2) whether the difference is due simply to soil and climate."

Probably all the hill cottons belong to *Gossypium neglectum*, var. *Assamica* of Watt in his " Wild and Cultivated Cotton Plants of the World." The most perfect form found in the Garo Hills is a very large bolled plant but a smaller bolled variety is also found. This Garo Hill cotton is pronounced to be the finest grown in the Hill tracts of the Provinces and its staple often reaches from $\frac{3}{4}$ to 1 inch in length. It must be remembered, however, that it is not used in commerce as cotton but as a substitute or adulterant in wool manufacture and that any attempt to improve it from the point of view of the cotton merchant would result in a serious diminution of price as it would then at once come into competition with the inferior grades of cotton which are so largely produced in some parts of India more accessible to the markets.

In the Chittagong Hill tracts and probably in all the other tracts also, a small bolled form is common. The cotton is shorter in staple than that of the Garo Hills and the percentage of cotton to seed is lower. We were informed by the American Missionaries at Tura who take special interest in cotton cultivation that they had been

unable to rear tree cottons. Taking into consideration the heavy rainfall of the Hill tracts, it is obvious that any experiment towards the introduction of ordinary commercial cottons, which seldom tolerate a rainfall of more than 40 inches, is doomed to failure. They have, however, promised to undertake trials with *buri* and Cambodia which are known to withstand heavy rainfall but even in the remote event of their success, it is difficult to imagine that they would thrive under the peculiar system of *Jhum** cultivation which, from all accounts, gives the indigenous plant exactly the conditions it requires. Mr. Hutchinson, the Superintendent of the Chittagong Hill Tracts informed me that he made a trial with *buri* cotton. The plants made a good growth and looked so well during the vegetative period that the cultivators were favourably impressed with its possibilities, but finally it refused to form bolls and thus was absolutely unproductive.

There is, of course, no doubt that the Garo Hill cotton is the best and the proprietor of the Ginning Factory at Chittagong classified the cottons according to value as follows :—

(1) *Garo Hill or Chilmari;* (2) *Jala* from Lamding, (3) *Bong* from Chittagong, (4) *Cachari* and *Comilla.* The difference in price to the cultivators between the best and the worst varieties may be only Re.1 per maund, while at the same time, it is understood that this may mean at least Rs. 4 or Rs. 5 to the merchant.

So far as I can gather, and I presume this to be correct, there are scarcely any appreciable differences of climate in these tracts and the rainfall is very heavy. The superiority of the Garo Hill cotton may be due to the great proportion of lime in the soil as calcareous rocks abound. I would suggest that samples of soils be procured from *Jhums** in the Garo Hills and Chittagong Hill Tracts for the determination of this point by the Agricultural Chemist. At the same time, it would be interesting if he could dis-

* Temporary fields made in a forest by cutting down jungle and burning it over the land.

cover the reason why *Jhums* require such a long period of rest. The mixture of crops in a *Jhum* seems to be regulated in such a way that each comes to maturity successively. Cotton is the last to do so and when ripening, it covers the ground at about the correct density for the production of a full crop. I learn from Mr. Hutchinson that he has tried the cultivation of Garo Hill cotton on the initiative of Messrs. Ralli Brothers and, in his opinion, the resulting cotton was in no way different from that of the prevailing variety of his district. Mr. K. C. Dewan, Sub-Deputy Collector, says the average acre outturn in Chittagong is 400 to 480 lbs. of seed cotton, while the average of 9 cropping experiments in the Garo Hills gives 500 lbs. of seed cotton and 254 lbs. of clean cotton. This is a percentage of cotton to seed of nearly 51. Taking the Chittagong cotton to have an average of 40 (and it is certainly not more) the acre outturn of clean cotton would only average 176 lbs., leaving an excess in favour of Garo Hill cotton of 78 lbs. per acre. From the bazar rates that I have been able to obtain, it appears that all the seed cotton is paid for at about the same rates while it is obvious that from its superior quality and higher ginning percentage, the buyer should give a higher price for Garo Hill cotton. At present, I understand that the cotton trade is in the hands of native merchants who make advances to the cutivators on the security of the crop and that the method of disposing of the produce finally to Europe is doubtful.

In conclusion, I would recommend (1) that no alteration should be made in the type of cotton grown as the experience of generations has taught it to be the only sort capable of growing under the excessive rainfall and the primitive agriculture of the Hill Tracts; (2) that any selection to be done should be undertaken with the view of increasing the length of the staple, and the percentage of cotton to seed, but not, however, with the idea of modifying the special characteristics of the product; (3) that the Garo Hill cotton should be experimentally introduced

into all the tracts so that it can pass under the judgment of local cultivators and the Chittagong cottons should also be tried on a small scale on the Garo Hills to find out whether the change of locality will affect it as regards size of bolls and quantity and quality of produce. All experiments should be placed under the supervision or control of some officer in the Agricultural Department, as work of this nature, when conducted by men with no training in agriculture, is either neglected or fails through lack of the necessary knowledge.

I have discussed cotton matters freely with Mr. Hector, the Economic Botanist, and he is in possession of my views.

Bengal.—There are three species of *Gossypium* cultivated in Bengal, *viz.*, (1) the late variety, G. *intermedium*, *Todaro* (probably), said to be grown most largely as a mixture with *rahar* and other crops in North Behar; (2) *G. neglectum Todaro*, vars. *Bengalensis* and *Kokatia*, comprised in the " early variety " of the agricultural returns and (3) an early maturing form of *G. hirsutum*, called *Buri*. In addition to these, two American tree cottons—Bourbon and Brazilian or chain-seeded are grown sporadically for their cotton which is used for spinning the sacred thread. Throughout Behar, cotton seems never to be grown as a pure field crop, but only as a mixture with *rahar* (*Cajanus indicus*). Probably little of the produce finds its way to the mills as the bulk is used for stuffing quilts and cushions and for other domestic purposes.

As regards projected experiments with a view of popularising cotton cultivation in Bengal only two species appear to hold out any promise of ultimate success. These are the *intermedium* and *hirsutum*.

According to Mr. N. C. Chaudhary who has devoted considerable attention to the subject of cotton cultivation in Bengal, the advantages of *G. intermedium* accrue from its heavy production and fineness of staple and its drawbacks are comprised in its long period of growth and low percentage of cotton to seed. The crop often occupies the ground until June or July, thereby delaying the cultivators

in the preparation of land for the *bhadoi* crop. The percentage of cotton to seed is said to be only about 20 and the outturn of clean cotton per acre from 50 to 150 lbs. The market rate of the cotton varies from Rs. 12 to Rs. 14 per Imperial maund. Mr. Chaudhary says, however, that owing to the shortage of the crop due to excessive rains, the price is this season at least Rs. 5 higher than usual and that Bhuri cotton has lately been bought by the Calcutta mills @ Rs. 30 per maund.

G. intermedium is said to be represented by two forms, one *Deshila* with small bolls and low percentage, the other *Bhogila*, with larger bolls and higher percentage.

By means of the usual methods of selection, it may be possible to improve these varieties (which are eminently suitable for the soil and climate of Bengal) in the points of which they are at present not quite satisfactory. I shall be obliged if Mr. Woodhouse, the Economic Botanist would undertake a trial on the Bhagalpur College Farm and perhaps Mr. Smith, the Deputy Director of Agriculture, might duplicate the experiment in one or more of his farms. The doubt as to whether these cottons will grow or not need not actually exist, the only questions involved are the possibility of increasing the outturn and percentage. At the same time, if samples are supplied to the Calcutta mills, it would be possible to decide whether or not these cottons are really worth growing. Areas of at least half an acre of each should be grown so that the outturns and percentages could be calculated on a fairly large scale and ample material would also be furnished for purposes of selection.

G. hirsutum, Buri, appears to have adapted itself admirably to the natural conditions of the higher lands of Bengal. In Central Provinces, the experience so far gained shows that it withstands a considerably higher rainfall than the local varieties, its outturn and percentage are high and the cotton is valued at the same rate as fine Broach which is accepted as the best of the cottons produced in India. In Bengal, it possesses the valuable charac-

teristic of being a short season variety and being of a low habit of growth it would not compete with a crop such as *rahar*. Its behaviour at the Chaibassa Agricultural Station proves that it thrives even under very unfavourable conditions. I would recommend that careful trials be made with this cotton in the way I have suggested above for *G. intermedium* and in the same localities. It was growing well on the Bhagalpur Farm and I can see no particular objection to its being grown on the Bengal plain. There is another cotton of almost the same characteristics known as Cambodia or Cochin China cotton. This is giving good results both in the Madras and Bombay Presidencies and I have reason to believe that it is still more resistant to heavy rainfall than *Buri*. If early application be made, a supply of seed could probably be obtained from the Deputy Director of Agriculture, Bombay Presidency, Poona.

As regards the two varieties of *G. neglectum*, I consider that they are scarcely worth dealing with, as they are no better than the common low grade cottons which predominate throughout the areas producing the so-called commercial Bengal cottons.

Of the tree cottons, Bourbon may be induced to yield as an annual crop, but it would be advisable not to exploit such an unsatisfactory class of plant.

If the officers of the Bengal Agricultural Department consent to carry out the trials I have suggested, they will not have to undertake a complicated task. They need merely study the possibilities of *G. intermedium* and *G. hirsutum*, the latter preferably in its two forms of *Buri* and *Cambodia*.

Central Provinces.—At the Telinkheri Farm, which I visited in the company of Mr. Clouston, the Deputy Director of Agriculture, the field of selected *Buri* looked extremely well and promised to be highly productive. Mr. Clouston had, with rare judgment, selected a type of plant with short, lower branches and I consider it very fortunate that at such an early period of the cultivation of

this plant he should have had the forethought to pick out what is clearly the best type of plant. I was also pleased to see at Akola that this type had been selected for growth on the seed farms. In Chutia Nagpur, the original Indian home of this variety of cotton, Mr. Woodhouse, the Economic Botanist in Bengal, and myself after examination of the mixed type in the field arrived at the conclusion that this was the type to work on and it was particularly interesting to see at Nagpur and Akola the facility with which this type perpetuates its character of growth. I consider that valuable work is being done in the improvement of cotton in these provinces by the rapid introduction of *Buri*. There is of course the danger of its failure in a season of drought, but in India success can only be attained by incurring a certain amount of risk.

I think that Mr. Evans, the Second Deputy Director of Agriculture, should carefully test the possibilities of this cotton within his charge. From favourable indications afforded by other indigenous varieties already there, I think, his trials will yield him good results. There is, however, at present great variation in the period at which plants ripen their bolls, some plants have completed the process before others have even started, but as all the cotton ripens well within the cold season, this circumstance is perhaps not one of practical importance.

Within the *jari* area, the variety *Malvensis* shows most promise. *Bani* grown at Akola being out of its natural element was actually priced lower than *Malvensis* at Jalgaon. This point is of considerable importance in its way as it goes to prove that *Bani* is the finest cotton in the Central Provinces and Berar only when grown in localities which have been found to be absolutely suitable to it, and care should be taken not to introduce it into tracts where the variety *Malvensis* of *Jari* is indicated as the safer plant to grow. Owing to its requirement for a heavier

rainfall than that prevailing in *Jari* tracts, *Buri* in time may supplant *Bani* or at least it may check the spread of *Jari;* so far as we can see at present, the latter will have no competitor. The only problem in its connection is to ascertain how the outturn of the fine varieties, such as *Malvensis* compares with that of the coarser.

I do not think that any type differing from those we already know will be discovered in this Province. Assuming this to be so, work in cotton should proceed on only a few lines and these may be summarised as follows :—

(1) The introduction of *Buri* to accompany Bani but by no means to oust *Jari.*

(2) The improvement of *Bani* in its percentage and outturn.

(3) The isolation of the different types of *Jari* (which has already been done) and the comparative value of each from the grower's point of view.

I would like to mention here that in my opinion a cotton plot should be at least an acre in extent as the details of outturn are of such vital importance. I find that on small plots too much attention is paid to individual plants and niggling selections are made in trifling differences such as minute variations in the length and quality of lint, etc.

The farmer and trader want to know the outturn and ginning percentage of the crop. The latter will not materially enhance his terms for trifling differences in quality and the former will insist on growing the variety which puts most money in his pocket. The cultivator loses money, however, through his predilection for sending dirty cotton to market. The merchant is often keener on making a good bargain than on paying the farmer higher rates for superior quality.

In addition to what he can secure from Mr. Clouston's long list of selections, I am arranging to supply Mr. Evans

with seeds picked from the best commercial samples obtained from his own division, and I expect he will shortly be in a position to carry through his demonstrations rapidly and soon reach the cultivators. From what I can gather, some of the cottons of his division are already considered good so that his task is simplified to a certain extent.

In conclusion, I wish to record my appreciation of the work being done in cotton by Mr. Clouston and by the projected experiments formulated by Mr. Evans. If they are supported as they deserve, I venture to predict that the Central Provinces will be the first in India to demonstrate that it is possible to obtain a decided improvement in Indian cotton, provided the requisite degree of intelligence and energy are brought to bear on the question and I again repeat that it is futile to work out our problems on flower bed areas.

Berar.—The Province of Berar known in days of yore by the name *Vaidarbha*, has been famous for the cultivation of cotton. It grew some of the best varieties yielding a fine strong fibre. It was the home of the once celebrated *Jari* and *Bani* varieties that afforded a superior sort of material not only to the mill industry in India but also to that in England. At the time of the Civil War between America and England in 1863, when no cotton was received from America, this province supplied the deficiency to a considerable extent.

Area.—Cotton occupies the foremost rank among other agricultural crops, and in comparison to the total cropped area, it is grown much more extensively in this province than in Bombay Presidency. It occupies the second place in India so far as cotton cultivation is concerned, Bombay Presidency being first. Nearly two-thirds of the culturable area is put under cotton, the average area ranging between 28 to 31 lakhs of acres per annum. The average outturn per acre is about 100 pounds clean cotton.

The following six talukas grow the bulk of cotton :—

Akola	740,000	acres.
Amraoti	700,000	,,
Basim	360,000	,,
Buldana	420,000	,,
Ellichpur	350,000	,,
Yeotmal	480,000	,,
	3,050,000	,,

Area under cotton in—

the Central Provinces	1,250,000	acres
Berar	3,000,000	,,
	4,250,000	,,

The valley of the Payanghat has an area under cotton to the extent of about 40 per cent. and this valley, it is said, grows the best cotton.

The area under cotton has of late considerably increased in the districts of Basim and Yeotmal as it is found to be more paying than other crops.

The earliest varieties grown in the Province were *Jari* (Chanda *Jari*) and *Bani*. The former was a cold weather variety with fine silky staple about $1\frac{1}{2}$ inches long; the latter was sown at the beginning of the rains and had a fine silky staple about an inch long. The best *Bani* was grown in the Wardha District and it was this variety mixed with a considerable proportion of Chanda *Jari* which was known to the trade as "Hinganghat". In Berar *Bani* (possibly with a mixture of *Jari*) was known as "*Amraotis*" or "*Oomaras*."

Now coarse Jari has come into existence which is sown at the beginning of the rains. This is hardier, coarse and prolific in outturn having a staple of about $\frac{1}{2}$ to $\frac{3}{4}$ inch long.

The two varieties (cold weather *Jari* and *Bani*) yielded a long staple but the outturn of *Bani* was less and was more delicate. Both these varieties had a reputation in the Bombay market until within the last 45 years; but they have been ousted by a variety known as *Kati Bilayati*,

Vilayati, *Houri* or new *Jari*. The evil seems to have been recognised as early as 1867. Dr. Humes then remarked that :—

"The subject of cotton in Berar is one that requires immediate supervision. It has been left in the hands of ignorant Koonbees, who have no thought for the morrow, but grow whatever pays best at the time. The Khandesh variety is being grown largely to the ousting of the other varieties, to the most certain ruin of the Berar cotton trade. At present they get from Vilayati Khandesh an early crop, also a large one, getting three or four pickings instead of two or three as they get from indigenous cotton. They get R3 or R4 a bale less in price than for the indigenous cotton, but the greater bulk compensates, and much more, for this small loss. But this apparent prosperity will be short-lived, for it is only by mixing this Valayati Khandesh cotton with the indigenous cottons that merchants can get it accepted."

The new *Jari* in recent years has become very popular as its character is sturdy and can stand both excessive rain and partial drought.

Mr. Gaskin, former Director of Agriculture, Central Provinces, says *Jari* is popular for its hardiness and certainty of its heavy yield (1,000 lbs. of seed cotton) giving 330 lbs. lint per acre; the ease with which it is picked up and the fact that it ripens early and so can be placed in the market in October, November.

Bulk for bulk its yield is much larger than that of old *Jari* and *Bani* though the staple is much shorter and less glossy. The old varieties come in the market in January and February whereas the present variety ripens much earlier and enables the cultivator to line his coat with silver in the months of November, December. These circumstances have mostly thrust out the old indigenous varieties of cotton. The change, it is said, came about in this way.

With a view to improve the cultivation in the province, Government introduced the seed known as *Vilayati* or *Houri*, also called *Jari* in some provinces, different from the old Berar *Jari*. The seed was distributed gratis. The trial was so successful and it became so popular that the

old varieties were completely driven out. In connection with the introduction of this variety, Mr. Gaskin observes that by the irony of fate the very cotton which Government endeavoured to eradicate became known as one which they had introduced.

Mr. B. P. Standen, C.I.E., former Director of Agriculture, Central Provinces, states " These are hardy plants which can be cultivated with success in any part of the province when the soil overlies the trap and drains early and the temperature of the cold season is not so low as to kill the plant in December ". According to him, *Jari* (the local *Houri*) has thrust out the old indigenous varieties, *Bani* and old *Jari*, because the former, even in the most unfavourable years, pays better than the latter. The same officer is of opinion that the cultivation of *Bani* on the Ghats south of Berar is due to a spirit of conservatism on the part of the cultivators rather than to any prudential consideration. Not only does *Bani* yield a smaller proportion of lint (25 per cent.) than *Jari*, but it gives also under the most favourable circumstances a small average crop and is more liable to damage from the vicissitudes of the seasons. For these reasons, the old famous varieties of Berar have dwindled and disappeared.

The *Jari* which is cultivated at present is a mixture of the following four varieties mixed to a small extent with Upland Georgian :—

(1) G. N. Rosea. (3) G. N. Vera.
(2) Do. Cutchica. (4) Do. Vera Malvensis, and also *Bani* plants.

Broadly speaking the fibre produced by these varieties increases in value as we go down the list, Rosea producing the shortest staple and priced lowest in the market.

To ascertain the relative value of the outturn of these different types, they were separated out and the seeds obtained were experimented along with Berar *Jari* and *Bani* on the Akola Farm in the year 1907-1908 by Mr. Clouston, the Deputy Director of Agriculture, Central Provinces.

The results are summarised below :—

Name of Variety.	Outturn of seed cotton per acre.	Percentage of lint.	Value of Outturn.
	lbs.		*R a. p.*
Malvensis	240	33	27 0 0
Verum	182	33	17 8 10
Roseum	258	39	24 14 0
Roseum Cutchica	194	38	18 11 3
Berar Jari	255	38	24 9 6
Bani	151	26	16 15 9

From the above statement, it will be seen that Malvensis having good staple has fetched more but the yield and percentage of lint are less than Roseum and Berar *Jari.*

The following was the valuation of these types last year :—

Roseum	₹54	per candy of	560 lbs.
Cutchica	₹54	do.	do.
Vera	₹54	do.	do.
alvensis	₹63	do.	do.
Bani	₹64	do.	do.

From the valuation, it is quite clear that Malvensis is a very promising variety and compares very favourably with the *Bani.*

During the current year at the Jalgaon Exhibition all these varieties were exhibited by the Agricultural Department of the Central Provinces. They were subjected to examination and the opinion given by the cotton merchants is as below :—

Buri.—Staple long, fine, good cotton. Value per candy of 784 lbs. ₹340.

Roseum.—Staple coarse, short, free from foreign matter. ₹268 per candy.

Verum.—Softer than Roseum ₹272 per candy.

Berar Jari.—Much cleaner than Khandesh. Will fetch a rupee or two more than ordinary Khandesh. Value ₹270 per candy.

Malvensis.—Not strong, but longer and silkier; much cleaner than Varadi. Value ₹295 per candy.

Bani.—Percentage 26, less silky but longer and stronger than Malvensis. ₹285 per candy.

Note:—Rough cottons are always cleaner than soft cottons.

The basis for valuation was Broach at ₹320 per candy.

Selection of seed.—Seed selection is known by the name of Alkabalka. At one time, it was practised extensively. The mode adopted was to select the best opened bolls at the second picking and stack the cotton. This was separately ginned and the seed so obtained was reserved for sowing for the next season.

Now-a-days on account of the introduction of ginning factories any seed is used for sowing and no effort is made towards selection. At the commencement of the gin factories, the machine ginned seeds were looked upon as unsuitable for cultivation, but this prejudice has unfortunately fast died out and the seed for sowing is purchased from Banias who give such seeds as they have at their own price. It is absolutely necessary to revive the old and useful practice of selecting seed and getting it hand-ginned.

Picking.—This is done usually after *Diwali*, by women and children. Payment is made in kind. 1-20th part of the cotton picked is the labour charges for the first picking; for the subsequent pickings, a higher proportion has to be given. These rates depend upon the cheapness of labour. If the labour is scarce, the rates are higher and *vice versâ*.

This practice is still in vogue in some places, but it has been replaced in recent years by cash payment as the cash payment is found to be cheaper. The usual rate of cash payment is annas three per maund of cotton picked. A

labourer is able to pick from a good field two to three maunds of cotton a day, thus earning from 10 to 12 annas a day. A good crop will give 3 pickings.

Outturn.—The average outturn of *Houri* is about 400 lbs. of seed cotton per acre and its average market price is ₹50 per Khandi of 560 lbs. An acre of land under cotton would thus give about ₹35 to a cultivator from which the cost of cultivation which is usually ₹14 may be deducted; the net profit would therefore be about ₹20.

Bombay.—During the year 1909-10 within a radius of 10 miles from Surat, the seed of a cross grown on the Surat Farm was distributed to the cultivators by the Agricultural Department. The produce of this cross, amounting to about 100 *bhars* 100,000 lbs. (960 lbs. make one *bhar* at Surat) has been purchased through the agency of the Bombay Agricultural Department by a gin-owner of Surat who gave ₹7 more per *bhar* for this cotton than the Surat local cotton. The quantity so purchased will gin out about 30,000 lbs. of seed; in addition to this quantity, the Surat Farm also will produce about 5,000 lbs. seed of this cross, the total quantity of seed would, therefore, come to about 35,000 lbs. It is the intention of the Deputy Director of Agriculture, Bombay Presidency, to distribute this quantity to the cultivators of one village only so that this year one village will grow only the cross cotton which will throw sufficient light with regard to the improvement of cotton.

Cordial acknowledgment is due to Messrs. Tata, Sons and Company, Bombay, for their kindness and promptitude in giving valuations and opinions on cotton samples whenever they were submitted to them.

Programme of work for 1910-11.—The work for the next year will consist of a further enquiry into the cottons of Central Provinces, Central India, Gujarat, Kathiawar and Southern Maratha Country.

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